[ESTABLISHED 1832]
THE OLDEST RAILROAD JOURNAL IN THE WORLD

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE, INC.
140 NASSAU STREET, NEW YORK

J. S. BONSALL, Vice-President and General Manager

Editors:
E. A. AVERILL. R. H. ROGERS

V. C. JONES, Western Representative
407 Medinah Bldg., Chicago

OCTOBER, 1911

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CARD INDEX HEADINGS

A year ago we started publishing in each issue a list of headings of the important articles in that number, arranged to be conveniently clipped and pasted on the card index cards of those of our subscribers who made a practice of keeping a complete card index. We also felt that these convenient headings might influence some of the younger men to start the habit of maintaining a complete card index of the more important articles in the various technical journals. These headings customarily required the space of about one page, the use of which for this purpose could only be justified by the assurance that they were accomplishing the results desired and were being appreciated and used.

After six months trial we decided, by discontinuing the practice, to determine to what extent these headings were being used and how important they were considered by our subscribers, knowing that such action would immediately bring a remonstrance from those who had found them valuable. We did receive objections from a number of subscribers and have continued to receive them for the past six months, but hardly in sufficient numbers to make us feel fully justified in reviving this section. Feeling that possibly some of our readers have objected to the discontinuance of these convenient headings, but have not felt strongly enough to register a kick, we are in some doubt in the matter and would be very glad indeed to obtain an expression of opinion from all who feel that this section should or should not be revived. The editors believe that these headings should be of value, but as we are publishing a paper for the reader, the matter is entirely in your hands for decision, and we would like to hear from you.

THE TRIUMPH OF THE MACHINE TOOL

The remarkable development to which the modern machine tool has been brought is not, as many imagine, the result of any random growth. On the contrary, each type of to-day represents the culmination of years of experiments and patient research, and of a character so elaborate as to be almost unbelievable. A certain machine tool builder, now deservedly prominent in the mechanical world, worked for over fifteen years in perfecting a heavy duty lathe through which its range of efficiency became easily doubled, although but 20 per cent. has been added to its original cost. Similar instances are plentiful, and are extremely interesting as illustrative of the potent influence of competition in business.

There is litttle doubt but that the machine tool builders of the United States have been foremost in this movement. Within the period previously referred to, fifteen years, driving powers have increased in some instances 300 per cent., while weights have increased say by 100 per cent. at least. The cost of experimenting before this revolution could be brought about has been very great. Recently a firm making milling machines spent over $25,000 in thoroughly testing one size of machine which they were placing on the market. The day appears to be on the wane when a machine tool builder can make any wide range, or various types of tools as the rapid strides in design and re-design would impose costs necessarily prohibitive. It is for this reason that specialization is now so prominent in this important industry, the range noticeable in the instance of several firms not being over two lines of machines.

The mechanical changes which have been made may be briefly summarized as a material strengthening of the old standard designs to secure rapidity of production and obtain accurate results with high-speed steels, and in the introduction of new features in both general and detail design to enable operators to produce rapidly with lessened physical and mental strain.

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of feeds. The usual method of a stepped cone is disappearing, and its place is being taken by gear boxes of variable-speed motors. Changing by gears is usually arranged to the medium size machine tools, and variable speed motors to the larger machines. The introduction of nearly perfect gear cutting machines and the use of hardened steel gears, with practically perfect continuous lubrication, have made the operation of the gear boxes practically noiseless.

The results of these changes have meant that not only can manufacturing costs be materially reduced, but more satisfaction is given to the workman. Speeding up a slow operator on a slow machine generally leads to friction, whereas on a tool designed with convenient motions an operator soon becomes interested in obtaining a rapid production.

As the machine tool designer has responded to the call for accuracy, there is now no longer any excuse for shop practice not providing correct work, and it is of course an admitted fact that accuracy is now possible and insisted on to a degree unknown only a decade ago. The American machine tool as it stands to-day is a monument to the patience, experience and ingenuity of its makers, and who are yet unceasingly striving toward further perfection.

THE MOUNTAIN TYPE LOCOMOTIVE

What a successful stoker means in locomotive design and train operation is well indicated by the new locomotives recently completed by the American Locomotive Company and put into service on the Chesapeake & Ohio Railway, which have been christened the "mountain" type. These locomotives have been deliberately designed to perform a service which practically requires the successful operation of a locomotive stoker and the accepting of the design by the railroad is the best evidence presented so far that the stokers have reached the stage where confidence can be placed in their reliability.

A Pacific type locomotive, having a total weight of 216,000 lbs. and a tractive effort of 32,000 lbs., is, even in these days, considered a large locomotive, and when there is presented the design of a simple engine which will easily do the work of two of these, a feeling somewhat akin to doubt is aroused, but the facts are present in this case and the locomotives are actually handling 12 cars on a schedule and over a division where the Pacific types have been handling only six cars. What this means to the operating department, of course, is easily conjectured and it is to be hoped that the men who have worked so long and conscientiously in developing the stoker are given the credit which they deserve, together with the designers of the machine itself and the officers of the motive power department for making such results possible.

In addition to its enormous power and its position as the largest simple locomotive in the world there are a number of other features in the design which make it of decided interest. Possibly the most prominent of these is the screw reverse gear, this being the first time this arrangement has been used in regular service in this country, although the American Locomotive Company applied it experimentally some time ago. The gear as arranged in this case takes but about six seconds for a complete reversal and it is stated that after becoming acquainted with it the enginemen recognize its evident advantages and favor it. Because of its extreme simplicity and positiveness of action it is probable that this type of gear now, once having broken the ice, will be used to a considerable extent on future heavy locomotives.

There have been cases where double heading of important trains has been resorted to, particularly in cold weather when one of the locomotives had ample power to handle the train alone, because of the impossibility of it going the full division without stopping to empty the ash pan. It is comparatively easy to figure from the quality of coal what the limits of continuous service are for a certain locomotive operating under any specified conditions. In the case of these mountian types which do the work and burn the coal of two Pacific type locomotives it would be readily apparent that they of necessity must have an ash pan of practically double the size if they are to run for the same distance. The designers have solved this question, however, apparently in a very satisfactory manner and have applied to this locomotive a pan having 83 cu. ft. capacity, arranged in six hoppers, four of which are outside the frames.

THE PHILOSOPHY OF SHOP MISTAKES

Human fallability to err is prominent in practically every walk of life, and those in railroad service, despite the voluminous rules laid down for their guidance and their own characteristic loyalty and high sense of duty, are by no means exempt. Blunders are committed from the highest in supervising capacity to the lowest. For many of them no explanation can be given. They are so inexplicable in view of the knowledge and experience known to be possessed by the person at fault that in the large majority of instances they are either condoned or forgiven.

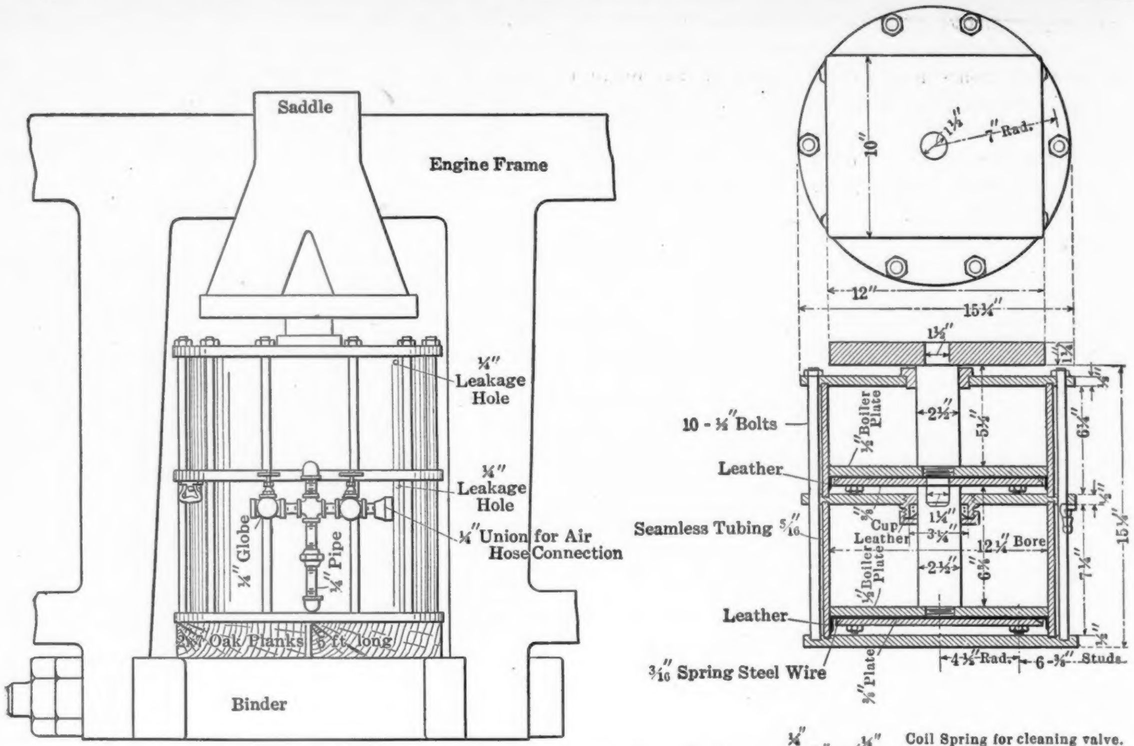
If those in authority are thus at times remiss it is but natural to assume that the rank and file, through probably a lessened sense of responsibility would be even more so, but singularly enough the reverse is the case. It is really astonishing to note the immunity from mistakes which prevails in the conduct of any railroad shop. When a man has been guilty of such it becomes a lurid light of warning whenever a job comes along wherein a similar error might be possible. The original blunder is never forgotten, and it is certainly a fact that no mechanic will commit the same error twice. There is nothing a man who has regard for his reputation dreads more than the discovery of blunders in his own work or in that of a department of which he is in charge. The feeling begotten is one of chagrin, as though some status were lost, and the majority of errors look so silly when discovered that they cause their perpetrator to feel very small.

Generally a man's position is not imperiled by an occasional mistake, even though it be a big one, and little, as a rule, is said about incipient errors discovered in the progress of work in any one department, but when the work is cleared out into another shop and the knowledge of errors become the public property of the shop, the thing wears a different aspect. The first thought of the foreman, who is rightly held responsible for all that occurs in his shop, is how will his employers regard the matter? Especially is this so when two or three mistakes follow in rapid succession. It matters little how many hundreds of errors he has detected and prevented in the face of the one or two that unfortunately pass his keen scrutiny. A single blunder overshadows ninety-nine good works, and, though condoned, he feels that it stands for a long time a black mark against him.

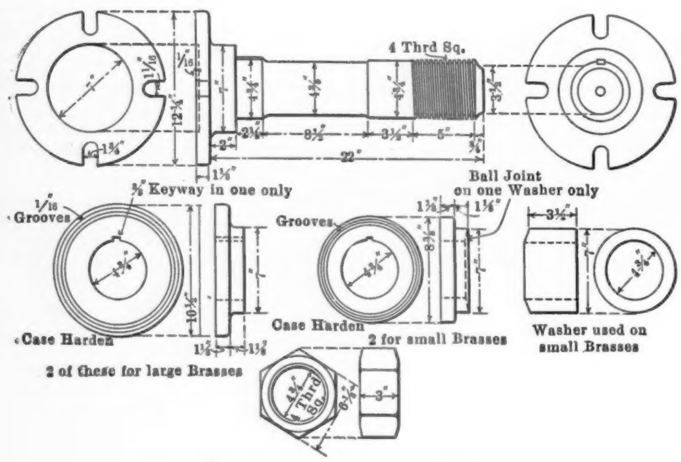
There is a great difference in managers in their treatment of men who have blundered. Broad views are taken as a rule. Some do not utter any reproach to a trusty and well-tried man, but simply discuss the best methods of repairing the error. Some lose their temper momentarily, but forget afterwards, while some draw a long face and utter the obvious truism that it is a serious matter, and that the workman who did it should be discharged. This latter procedure, however, is seldom in evidence, as from what has been said it is appreciated that the compunction of the offender will serve as an adequate punishment.

In a general or average sense all blunders are preventable, and yet a certain percentage is made in every shop during a year and always will be. The lesson taught by them is the same which all have to learn in the conduct of life. No one is exempt from mistakes, but these become danger signals to prevent or lessen the recurrence of like errors.

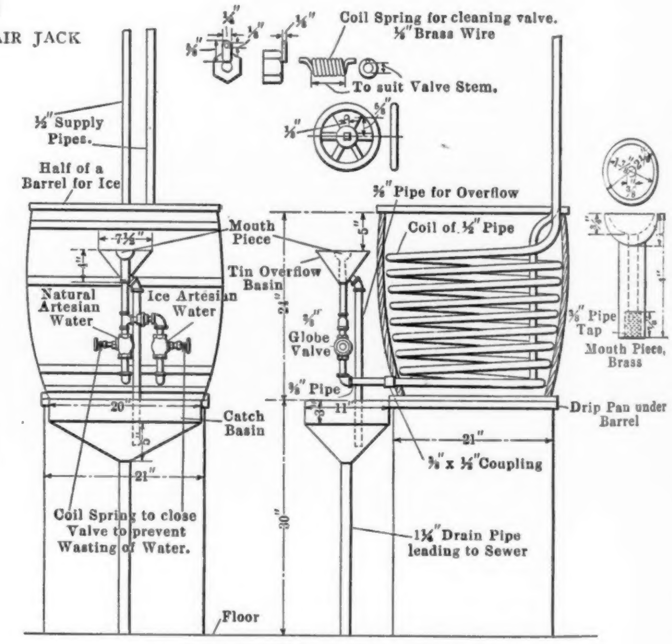
It is the everlasting tribute to the American railroad or shop man that he appreciates this lesson, and while bitter at the time every mistake has its corrective value as an insurance against repetition.



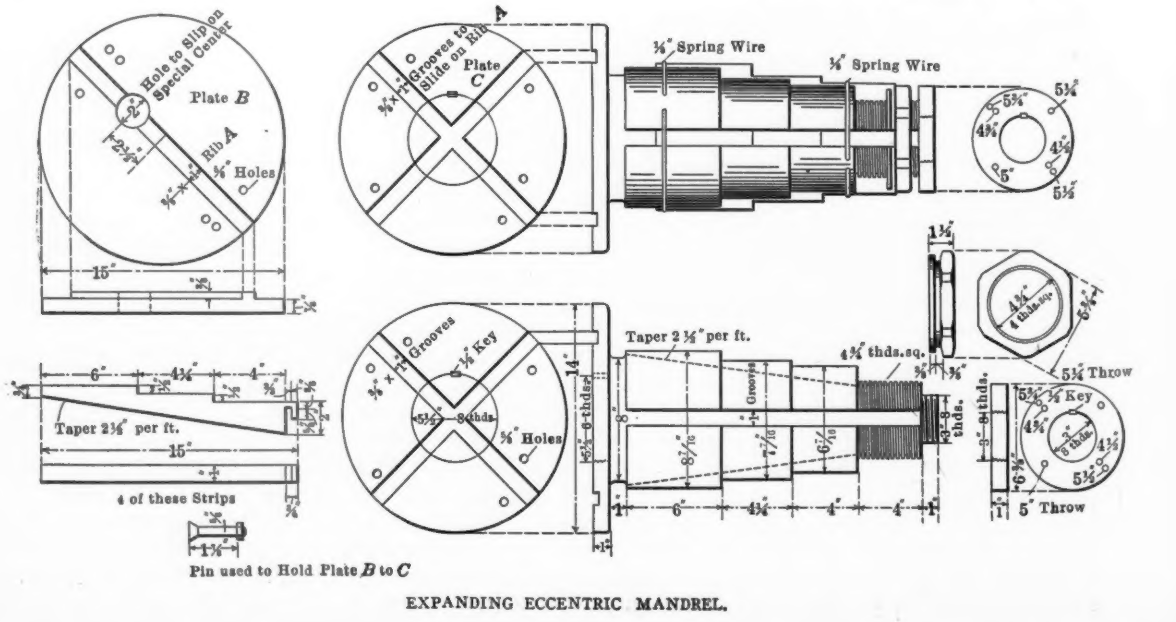
DOUBLE AIR JACK



DRIVING BOX BRASS MANDREL.



SANITARY SHOP DRINKING FOUNTAIN.



EXPANDING ECCENTRIC MANDREL.

SOME NEW JIGS AND METHODS

CHICAGO & NORTH-WESTERN RY.

The Chicago and North-Western Ry. has of late developed many ingenious labor-saving devices in connection with shop work which are entitled to particular consideration. While some of these may not be generally applicable, they are still of sufficient interest to be briefly described and illustrated for whatever value each may have to those who are combating the problem which each represents.

Prominent among those herein illustrated which have been evolved by the various foremen and master mechanics of the railroad, but largely at the Clinton shops, is the double air jack for blocking up springs under Atlantic type engines with fairly wide pedestals. The operation in general wherein the jack is used is a drop pit proposition pure and simple, and the intent is to relieve the drop pit jack of all work other than that required to merely pump the drivers from the pit into their normal position.

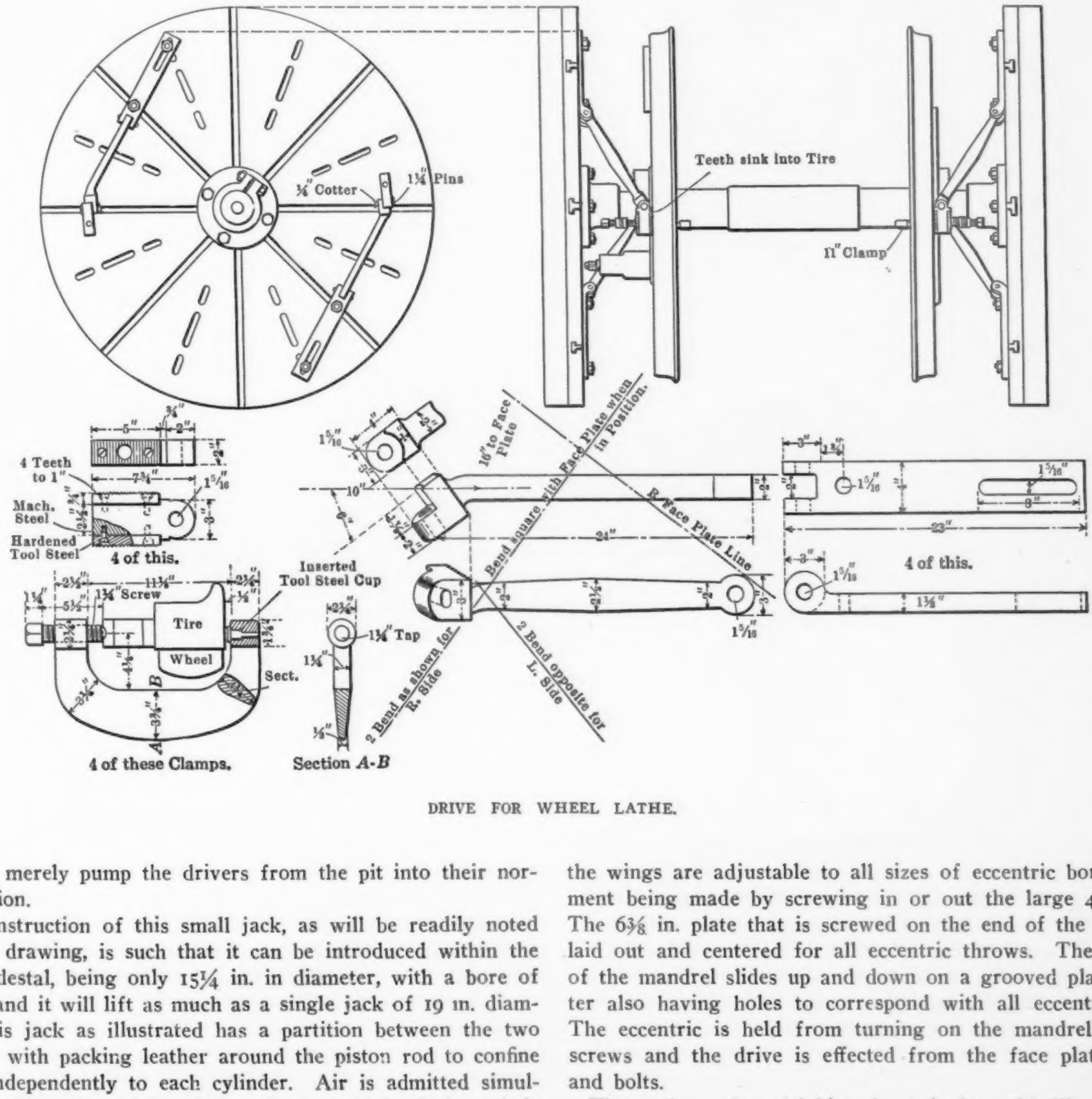
The construction of this small jack, as will be readily noted from the drawing, is such that it can be introduced within the frame pedestal, being only 15¼ in. in diameter, with a bore of 12¼ in., and it will lift as much as a single jack of 19 in. diameter. This jack as illustrated has a partition between the two cylinders, with packing leather around the piston rod to confine the air independently to each cylinder. Air is admitted simultaneously through a ¼ in. globe valve. A ¼ in. leakage hole is placed in the top of each cylinder to prevent the equalizing of air. The constructive details need not be further commented upon as they can be readily understood from the drawing.

In connection with this device the idea might reasonably suggest that its use would be unnecessary provided that the saddle had been blocked as a preliminary, and before any wheel dropping was resorted to, which is true enough, but as is of course understood it frequently becomes necessary while an engine is on the drop pit to change springs or hangers and in such contingency the device must prove of considerable value.

The driving box brass mandrel shown herewith in detail is in very successful operation in the Clinton shop of this road, where through its use a brass for a 9½ in. by 12 in. journal can be turned up in twelve minutes, taking a roughing and a finishing cut. This quick time is realized by the size of the arbor and its weight. This is fastened and carried by the lathe face plate, which also centers that end of the mandrel by a recess in the face plate and a shoulder on the bar. The brass is held in place by the two washers and large nut. The majority of railroad shops use mandrels held on centers and driven by a dog, a known to be unsteady arrangement which factor this new design is intended to eliminate. It is very highly commended where used, both for ease of operation and for its substantial construction.

Another interesting device of somewhat similar character is the expanding eccentric mandrel which is very clearly shown in the accompanying detail drawing. The arrangement provides for a very solid drive. It is quickly applied to a lathe and produces work of remarkable accuracy. It will be noted that the wings are adjustable to all sizes of eccentric bores, adjustment being made by screwing in or out the large 4¾ in. nut. The 6⅜ in. plate that is screwed on the end of the mandrel is laid out and centered for all eccentric throws. The other end of the mandrel slides up and down on a grooved plate, the latter also having holes to correspond with all eccentric throws. The eccentric is held from turning on the mandrel by its set screws and the drive is effected from the face plate by strap and bolts.

The sanitary shop drinking fountain herewith illustrated does not embody any particular novelties in design, as the coil system has been used generally in shops for many years to cool drinking water, but it is included among the special devices principally on account of its simplicity, and in recognition of the fact that it can be produced at a very low cost. The principal feature is, of course, the fountain, and with reasonable care it should not be wasteful of water. As a precaution against this the valve stems are fitted with coil springs which automatically close the valve when the handhold is released. It is also clear from the drawing that the water does not mix with the ice, the latter being broken up and packed around the pipe coil.



DRIVE FOR WHEEL LATHE.

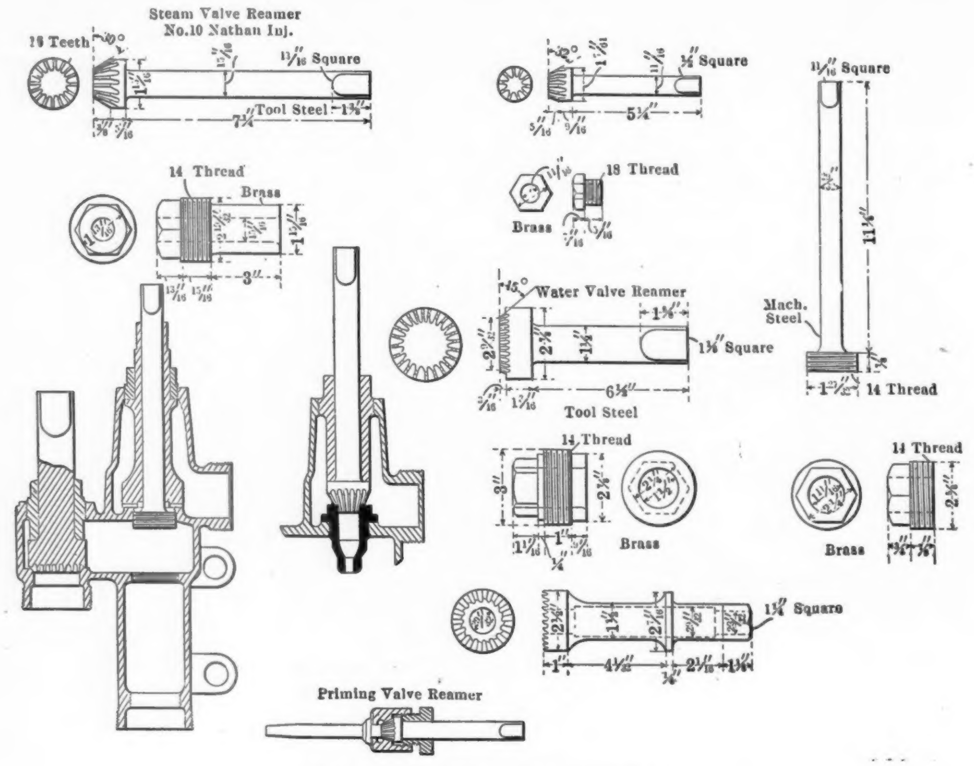
The funnel shown catches all waste water which is conducted to a sewer or any convenient point.

In connection with this arrangement it might be said that railroad shops as a rule are surprisingly lax, in view of the general agitation over sanitary drinking facilities, in making suitable provision in this line for the shop men. Existing appliances in this line range from a chunk of ice in a bucket, with the accompaniment of a common dipper, to a metal cooler with chained tin cup attached. It need not be mentioned that the ice which is in direct contact with the water is seldom if ever washed, and the drinking cup never. With these considerations in mind this cheap and undoubtedly economical fountain becomes of interest.

A first-class home-made wheel lathe drive has been evolved in the Clinton shop which is not by any means the least interesting example of the ingenuity displayed in that quarter. The details are so clearly apparent in the drawing that little standardize the various operations that the least possible expenditure of time and money is assured.

The Chicago and North-Western Ry. has been actively engaged in this latter work for some time, and is now handling by special standard reamers all re-seating which injectors generally require when they pass through the shop. A set of these tools which are used in connection with the maintenance of the Nathan "No. 11" injector is shown in the accompanying illustration. These tools are used by hand, simply by being turned a few times and fed to the work by the nuts as shown. They are not only great labor savers, but embody the additional valuable feature of insuring that the seats are maintained on their original angle. Without them it would be necessary to put the injector in a lathe, which is a cumbersome undertaking, and generally implies an unsatisfactory job with much after grinding.

The large tool in the drawing which lines up the flat seat



STANDARD INJECTOR REPAIR TOOLS.

description is necessary. It is quite evident that the heavier the cut the tighter the steel dogs must grip into the tire. The range of the appliance is remarkable as it will drive from 42 to 74 inches, simply by sliding the dogs in or out on the face plate. When the wheel is being put into or taken out of the lathe the dogs swing back against the face plate, leaving free opening. The dogs are held against the tire by four horseshoe clamps as shown. From what can be learned of the operation of this device it is considered to be far superior to a spoke drive from the face plate, the well-known objection to which being that it is not constant, and necessarily of a more or less unsteady character. The only objection which might be advanced against its use is the scarring of the tire by the teeth of the dogs, but this is so slight that it need scarcely be considered. It is really astonishing that this is not more apparent, but in the case of some of the heaviest cuts the tires scarcely show a mark.

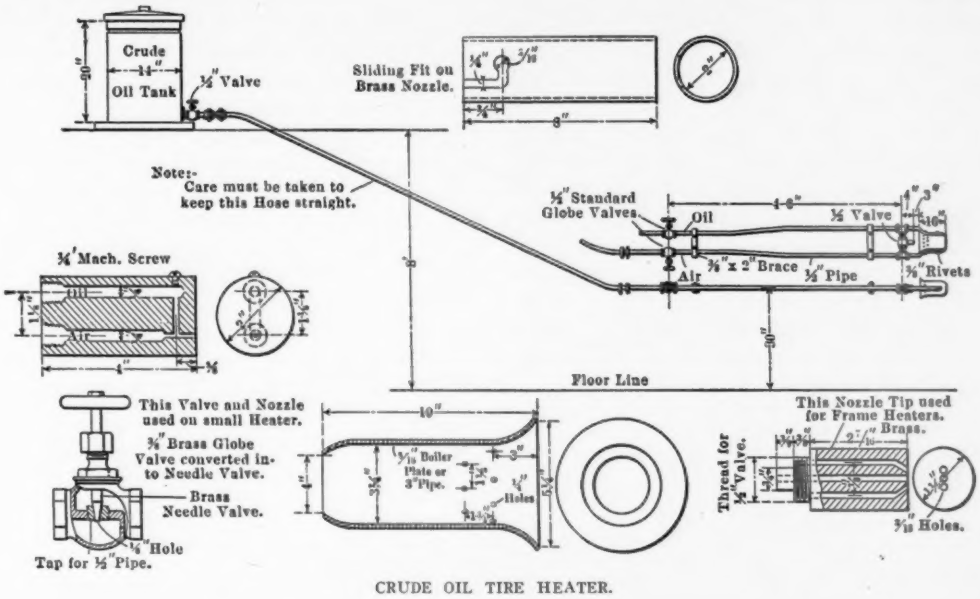
On a division having say 150 locomotives the question of injector repairs resolves into considerable proportions; one which needs to be dealt with intelligently, and with the aid of special devices to result in a smooth and satisfactory handling. In instances where the various types of injectors are restricted the repair department dealing with that item is fortunate in being able to hold its special reamers, etc., to a minimum, and to so for the steam valve, has its steel spindle threaded to fit the threads in the body of the injector where the steam nozzle screws in. This spindle centers and guides the flat seated reamer, the latter being drilled through its center to fit the spindle. The reamer being thus held in line it is fed by the nut screwed in the bonnet opening on the injector. It will be noted that the water valve reamer is designed to cut down the top of the seat at the same time the bevel is being formed, thus keeping the seat always the same width. These tools were designed by H. Killean, tool maker, at the Clinton shop, and have greatly simplified the operations heretofore associated with such repairs.

A dependable crude oil heater is now generally recognized as a valuable accessory to shop and especially roundhouse equipment, in view of the occasions which frequently arise where it could be employed to great advantage in obviating the removal of a part for heating with the accompanying delay and expense. For instance, bent channels on tenders, cars, etc., frequently require this treatment, and in particular the oil welding under the engine of broken frames, which is now practiced on several railroads, necessitates an appliance which will raise the part to be worked on to the desired temperature quickly and cheaply.

The heater illustrated herein is also a product of the Clinton shop and is being used at that point with great success. Its ex-

treme simplicity is readily apparent in the drawing, so that no description is necessary.

To operate it the oil tank is partly filled with crude oil, and is simply placed higher than the piece to be heated. If a short, quick heat is required a few fire bricks are usually placed around and over the part as a preliminary. When ready all that is necessary is to open the oil and air valves and a piece of burning waste at the burner will start operations. The only



CRUDE OIL TIRE HEATER.

manipulation required for the device is that of securing the proper regulation for the two valves mentioned.

While crude oil heaters are far from being a new idea, either in theory or practice, it is believed that the one under consideration embodies less complexity and is cheaper and more substantial than the general run of such devices which may be encountered in railroad shops.

WESTINGHOUSE NEW AIR BRAKE PLANT

The Westinghouse Air Brake Company has just closed negotiation for the purchase of a site at Emeryville, Cal., upon which it is soon to commence the erection of a large plant for the manufacture of its various products. Negotiations for the purchase have been under way for more than a year, but have only recently been closed.

For a long time it has been recognized that the company needed a plant on the Pacific Coast in order that it might be in a position to serve the needs of Japan, Manchuria and other Oriental countries in a more efficient and prompt manner than has been possible in the past. It is stated that the use of air brakes manufactured by the company is becoming more popular each year in the countries mentioned and the demand has become so large that it was not practicable to ship such product from the East clear across the continent and reship them from the Pacific Coast.

The trouble has been that being shipped so far in many instances considerable damage was done to machinery en route and it was feared that such results would result unfavorably in time unless rectified. The Westinghouse Air Brake Company intends to push its Oriental trade to a greater extent as soon as its California plant is completed. It is expected that there will be a liberal demand for the company's product as soon as the Oriental people become educated up to the fact that it will be possible and that the goods will be received in good condition.

THE RAILWAY BUSINESS ASSOCIATION

The members of the Railway Business Association have received notice of the third annual dinner, which will conclude the annual meeting on Wednesday, November 22, 1911, at the Waldorf-Astoria, New York.

The notice reads as follows:

"On this occasion, speakers of the first prominence, representing each a phase of the live railway problems of the hour, will unite in a notable exercise of influence upon public thought and sentiment toward transportation and industry. The guests will include an impressive representation of our national leaders in transportation, industry, commerce, finance, the professions and public life. The prestige from our previous dinners and from our record of conceded accomplishment in constructive publicity will serve to whet the general eagerness to participate in the function of 1911.

"Already the enthusiasm of our members has manifested itself in requests for reservations, though it has been thought fair to inform all such that requisitions could not be received until after the formal announcement of the date had gone to all members alike. There will without doubt be a subscription in excess of the capacity of the dining room, which is definitely limited.

"All companies who are members of the Association are entitled to subscribe for as many seats as they desire for themselves and friends whom they wish to take this opportunity of honoring."

In view of the disappointment suffered by many in 1910 through delay in subscribing, members are advised not to wait for acceptances from invited guests, but to file reservations at once. Announcements will be made at an early date of the names of the speakers.

THE PIONEER LOCOMOTIVE SUPERHEATER.—The earliest recorded attempt at using the principles of superheating was made in 1828 by Richard Trevethick at the Birnie Down Mines in Cornwall, on a condensing pumping engine making eight revolutions per minute, with a boiler pressure of 45 lbs. per square inch. At this slow speed, and with such lagging materials as were in use in those days, the condensation was very great. Trevethick conceived the idea of reheating the steam in the cylinder to re-evaporate the condensation. To attain this end, the cylinder and piping were surrounded with firebrick and heated from a fire on a grate beneath. A remarkable saving was noted; ordinarily 9,000 lbs. of coal were consumed per day, whereas with a fire under the cylinder, only 6,000 lbs. were required, including the coal for the superheating grate. This led to further experiments by Trevethick, resulting in his tubular boiler and superheater in 1832, which, it is claimed, is quite modern in appearance.

AT THE PANAMA CANAL ZONE most of the railroad construction now is done with the assistance of compressed air. All the rivets are driven with air hammers. Other uses—the brake on all the dump cars, the fans, and so on—need not be enumerated.

Oil Burning Passenger Locomotives 2-6-6-2 Type

SOUTHERN PACIFIC COMPANY.

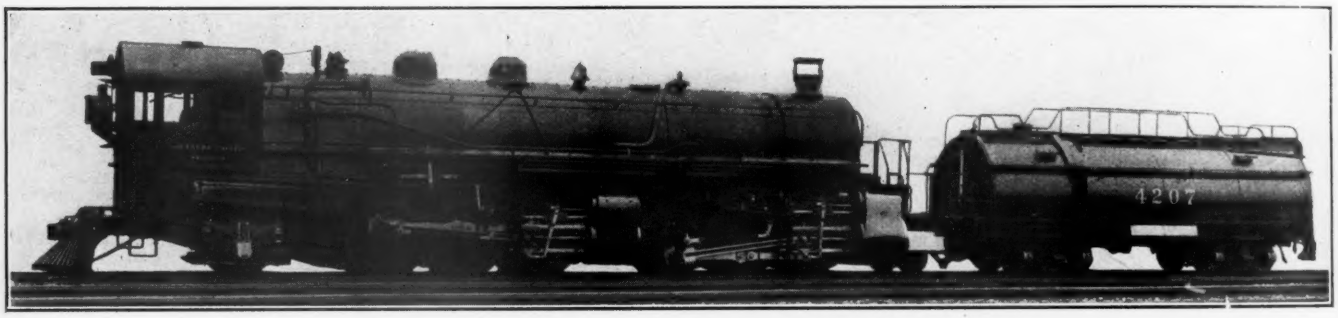
Twelve Mallet articulated compound locomotives which will be used in passenger service on the Sacramento Division of the Central Pacific R. R. by the Southern Pacific Company have recently been received from the Baldwin Locomotive Works. On this line, eastbound, there is a continuous ascending grade from Sacramento to Summit, a distance of 105 miles. The total rise is 7,000 feet, and the maximum grade is 116 feet per mile for about 40 miles. Since 1907, passenger service on this division has been handled by ten-wheel locomotives built to Associated Lines standards, and weighing 203,000 pounds, with 160,000 pounds on driving wheels. The tractive effort exerted by one of these locomotives is 34,700 pounds, and two engines are required to handle a 500-ton train on the 116 foot grade. Each of the new Mallet locomotives is equivalent, in capacity, to two of the older engines, and under ordinary conditions double heading of pasenger trains will thus be avoided in the future. In general the design of the new locomotives follows that of the Mallet freight locomotives with 2-8-8-2 wheel arrangement, which have been in successful use on this division since 1909.* A number of modifications have been introduced, however, and these include some features which are new to the practice of the builders.

Separate type boilers as usually applied by the builders to locomotives of this capacity have been specified. In the present instance, however, the dome is placed a short distance ahead of the firebox, and an internal dry pipe conveys the steam to the intermediate combustion chamber. This chamber contains right and left hand steam pipes of ordinary construction, and these communicate with short outside horizontal pipes, which lead to the top of the high pressure steam chests. The high pressure exhaust is conveyed to the smoke-box through a horizontal pipe located in a large flue which traverses the water heater. The flexible receiver pipe is placed on an angle under the smoke-box.

Inside admission piston valves, of the built-up type 15 inches in diameter, control the steam distribution to all cylinders. No by-pass valves are used, but a large relief valve is tapped into the steam pipe leading to each cylinder. The low pressure pistons have extension rods, and these are supported at their outer ends, on crossheads. The guides for these crossheads are supported by the cylinder heads and cast steel bumper beam. The crossheads have cast steel bodies and bronze gibs, and bear on the tops of the guides only.

Interposed between each high pressure cylinder and the saddle is a slab frame, 26 inches deep and 2½ inches wide. This slab is spliced to the main frame by 21 bolts each 1½ inch in diameter, and by two vertical keys driven in a parallel key-way with their tapered faces in contact. The same plan is used for keying the frames to the cylinders and saddle. The saddle itself is of cast steel and is composed of two sections. The lower section extends the full depth of the slab frames, and supports the hinge pin, which is 7 inches in diameter. With this arrangement the separate crosstie heretofore used to support the lower end of the hinge pin is combined with the saddle casting, and the cylinders, frames and saddle are bolted and keyed together to form a strong and rigid structure. The low pressure cylinders are bolted directly to a steel box-casting which is secured to the frames in accordance with the customary practice of the builders.

Similar to the Mallet freight locomotives mentioned above these locomotives are designed to run firebox end first, in order to give the enginemen an unobstructed view of the track. The truck under the firebox, therefore, becomes the leading truck. This truck is of the Hodges type, with spring links so jointed as to allow a fore-and-aft as well as lateral motion. A new design of centering device is applied to this truck. A double coil centering spring is used, and it is held in a vertical position, between two cast steel washers, and is guided by a vertical thrust bar. This thrust bar is placed on the center line of the locomotive and is suspended from a crosstie. Interposed between the top spring washer and the crosstie is a bearing plate. Two pins, each 2 in. in diameter, are placed between the bearing plate and the crosstie, and on these pins is suspended a U-shaped strap, which is wide enough to embrace the spring washers. A link connects the lower end of the strap with a lug which is bolted to the truck frame. When the frame is displaced from its middle position, the strap is pulled to one side, and one of the upper pins is drawn down, thus pushing on the bearing plate and throwing the spring into compression. The bottom spring washer is held in place by a link which is pinned to the engine frame.



POWERFUL OIL BURNING PASSENGER LOCOMOTIVE.

These locomotives are equipped for burning oil, and the tenders are coupled at the smoke-box end. The two tanks are semi-cylindrical in shape and are placed end to end. They have respective capacities for 3,200 gallons of oil and 10,000 gallons of water. The tender frame is composed of 12-inch channels weighing 40 pounds per foot, and strongly braced transversely, while the end bumpers are of cast steel. The tender trucks and also the back engine truck, are equipped with forged and rolled steel wheels.

In designing these locomotives, full advantage has been taken of the experience gained with the Mallet freight engines which have been operating for some time on the Central Pacific. Special attention has been given to the steam distribution, and to providing ample sectional areas in the steam and exhaust piping. Although the duty which these locomotives are intended to per-

*See AMERICAN ENGINEER, May, 1909, page 181.

form is exceptionally severe, there is every reason to anticipate that they will prove successful.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Passenger
Fuel	Oil
Tractive effort	66,000 lbs.
Weight in working order	384,800 lbs.
Weight on drivers	320,100 lbs.
Weight on leading truck	21,000 lbs.
Weight on trailing truck	43,700 lbs.
Weight of engine and tender in working order	568,000 lbs.
Wheel base, rigid	11 ft.
Wheel base, total	51 ft. 4 in.
Wheel base, engine and tender	85 ft. 1 in.

RATIOS.

Weight on drivers ÷ tractive effort	4.85
Total weight ÷ tractive effort	5.83
Tractive effort × diam. drivers ÷ heating surface'	584.20
Total heating surface* ÷ grate area	101.67
Firebox heating surface ÷ total heating surface* %	3.30
Weight on drivers ÷ total heating surface*	45.00
Total weight ÷ total heating surface*	54.00
Volume equivalent simple cylinders, cu. ft	23.56
Total heating surface* ÷ vol. cylinders	302.08
Grate area ÷ vol. cylinders	2.97

CYLINDERS.

Kind	Compound
Diameter and stroke	25 & 38 x 28 in.

VALVES.

Kind	Piston
Diameter	15 in.
Lead	5/16 in.

WHEELS.

Driving, diameter over tires	63 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	11 x 12 in.
Driving journals, others, diameter and length	10 x 12 in.
Engine truck wheels, diameter	30½ in.
Engine truck, journals	6 x 10 in.
Trailing truck wheels, diameter	45 in.
Trailing truck, journals	8 x 14 in.

BOILER.

Style	Straight
Working pressure	200 lbs.
Outside diameter of first ring	82 in.
Firebox, length and width	120⅝ x 84 in.
Firebox plates, thickness	⅜ x ½ in.
Firebox, water space	5 in.
Tubes, number and outside diameter	495-2 in.
Tubes, length	20 ft. 6 in.
Heating surface, tubes	5,292 sq. ft.
Heating surface, firebox	235 sq. ft.
Heating surface, total	5,527 sq. ft.
Feed water heating surface	1,590 sq. ft.
Grate area	70 sq. ft.

TENDER.

Wheels, diameter	33 in.
Journals, diameter and length	6 x 11 in.
Water capacity	10,000 gal.
Oil capacity	3,200 gal.

* Includes feedwater heating surface.

ACCOUNTING BY THE STOREKEEPER

In a very important and interesting paper entitled "The Accounting Department in Connection with the Mechanical and Stores Department"—read before the Canadian Railway Club, A. A. Goodchild, auditor of stores, and mechanical accounts, had the following to say anent the railroad storekeeper and the work of his department:

Let us discuss for a few moments the duties, responsibilities, and qualifications of a storekeeper, and in doing this, we shall deal with only the general practice of roads whose storekeepers are the custodians of unused material. The larger question as to the duties of taking cognizance of all material until actually used may be left to some future consideration.

These duties bring him in constant touch with the entire operating department of a road. Locomotive, car, bridge and building, transportation, and other branches of the service are dependent upon him for supplying the necessary materials with which to carry on the work, whether it be construction of a thousand box cars, or the putting on of a patch to the side of a car, the building of cars, large monster locomotives, or the supplying of a tender truck box cover, wherever we find material being used, there also we find the storekeeper an interested party, and this interest entails upon him the need of cultivating a very close acquaintance with the heads, and the requirements of the various departments. He is above all also an operating official, and should be able at all times to supply the material needs of the entire railroad. These needs are varied. No line of business can be excluded from its voracious maw. Hardware, glass, oils, paints, drugs, acids. The precious metals, lumber from the cheapest to the most expensive, minerals, coals, coke, road and shop tools of every description, office supplies, flour, cement, silks, furniture, carpets, and so on, *ad lib*, all serve to appease, but never satisfy the hunger of our railroad systems.

What kind of a man is required to cater to all these varied needs, and to cater intelligently, in order that he may furnish the maximum amount of satisfaction at a minimum expense to his employers; be ever ready to fill the orders and never overload himself with material which the aesthetic taste of a superintendent of motive power, or a master car builder refuses to attempt to digest? Surely a man to fulfil such requirements must be a paragon, surely such duties in themselves entail a large enough field for the most industrious cultivation, and the requisitioning for, receiving, storing, and disbursement of such material, calls for the very highest ability taxed to its utmost capacity. Having those requirements in mind, let us glance briefly at the various steps one must tread before he can reach the topmost rung of the storekeeping ladder. Let us enter one of our large stores, and as we pass along we find our man trucking castings or unpacking boxes of various materials, may be, sweeping away refuse. Later on he is found loading material into cars or getting articles down from the shelves, assisting a storeman. He advances steadily, and is, perhaps, given charge of certain divisions or sections of the store house, and in the fulness of time is called upon to assume charge over the entire section or store.

Hitherto, his work has been manual, but now the stock cards and books engage considerable of his attention, for he is required to know the exact condition of his stock to enable him intelligently to place requisitions for the depleted material, he must know what the average monthly consumption is, how far his stock will provide for ordered requirements, what quantity if any he has on order, and whether through some special or irregular condition he is likely to be called upon for more than his normal supply. Thus it has become necessary for him to devote considerable time and attention to book records. This may be, and frequently is, an entirely new experience for him. Coupled to this, under the system which is still largely in vogue, he must devote his attention to the accounts of his store. The debits and credits are impressed upon him as important factors. For this purpose he engages a clerk, if the funds will permit, who does the necessary book work and accounting for him, and in his ignorance of the merest theory of such work, signs statements and records which are put before the management of a railroad.

It is general practice when a storekeeper keeps his own accounts, for him to keep those of the mechanical department also, the stores being very closely allied thereto, especially in a large plant where considerable manufacturing is carried on for road purposes. This necessitates his becoming a timekeeper, as the largest disbursements of mechanical accounts are for labor. He must become an authority on distribution of such labor and exercise a prerogative in connection with shop system, contract work, etc. Is it not hopeless to expect a man with a training which I have briefly outlined, to meet such varied requirements? With all respects to the large number of able general storekeepers on this continent, I affirm that they cannot devote their attention to storekeeping, accounting, and shop systems, with justice to either branch of the work. Indeed, there is very little, if any, attempt at doing this, as a matter of fact. It is largely a fiction. The clerk is held responsible for statements, etc., issued under a storekeeper's signature for the reason that the storekeeper himself has no time to attend to such matters, and not infrequently looks upon them as of very secondary importance, or is lacking in a proper appreciation of the value of such duties, and he almost naturally develops a tendency to protect the stores account at the expense of those of the mechanical department. Quite apart from the question of integrity of the departmental officials, a feeling of dissatisfaction inevitably underlies all questions of disputed costs.

Speaking from experience I have no hesitation in affirming that it is a simple matter to load an account with items which should never be charged thereto, and to so manipulate accounts as to afford more than ample protection to the storekeeping department. There was a time in the recollection of many, when the necessity for proper accounting methods and men was not realized as it is to-day. Everything pertaining to the accounts, from the man who "wanted to know" to the underpaid clerk who was expected to "show," was accorded very little consideration, and one can almost understand how it came about that the storekeeper was looked upon as a sufficiently informed and responsible person to take charge of accounting and timekeeping, but to-day, and I venture to say, never more than to-day, it is considered proper and necessary for this work to be handled by men whose minds have been thoroughly trained thereto.

Mr. Goodchild closed his paper with a very strong plea for the accounting of the stores department to be under the direc-

tion of the general staff of accountants. He believes that auditing or accounting by an independent officer should make for real efficiency, and added that speaking for himself he welcomed an outside auditor, who may be authorized to do so, going over the methods and analyzing the principles upon which the work is conducted, showing up any weak spots in order that whatever remedy is found necessary may be applied.

STATISTICS OF RAILWAYS IN THE UNITED STATES

Statistics issued by the Interstate Commerce Commission show that on June 30, 1910, there was a total single-track mileage of 240,438.84 miles in the United States, indicating an increase of 3,604.77 miles over the corresponding mileage at the close of the previous year. An increase in mileage exceeding 100 miles appears for California, Florida, Georgia, Minnesota, Mississippi, Nevada, Oklahoma, Oregon, Texas, Washington, West Virginia and Arizona.

There were 58,947 locomotives in the service of the carriers on June 30, 1910, indicating an increase of 1,735 over corresponding returns for the previous year. Of the total number of locomotives, 13,660 were classified as passenger, 34,992 as freight and 9,115 as switching, and 1,880 were unclassified.

The total number of cars of all classes was 2,290,331, or 72,051 more than on June 30, 1909. This equipment was thus assigned: Passenger service, 47,095 cars; freight service, 2,135,121 and company's service, 108,115. The figures given do not include so-called private cars of commercial firms or corporations.

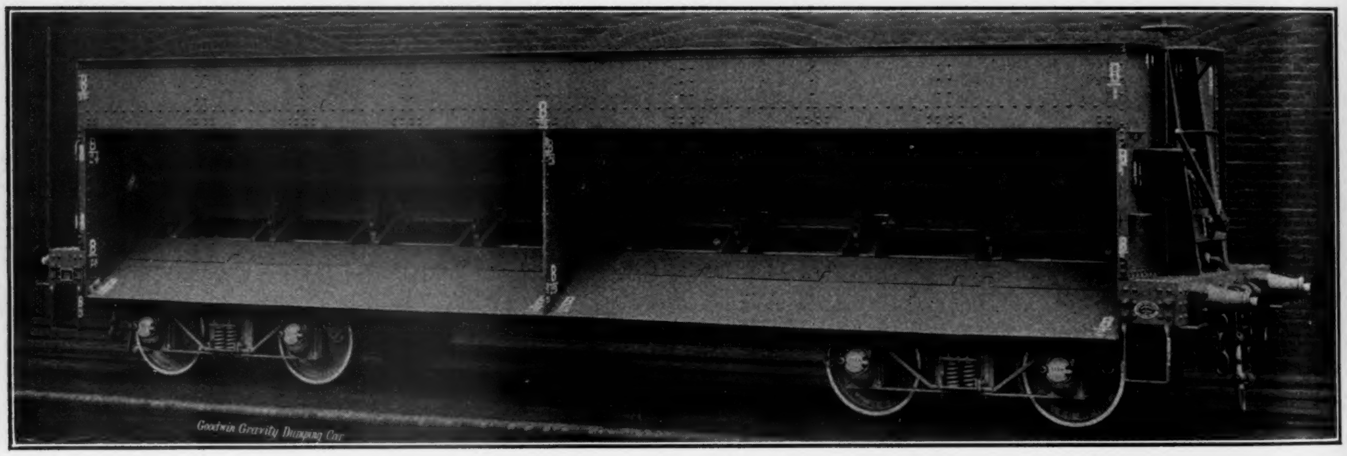
NEW MIXED TRAFFIC LOCOMOTIVE.—The Great Western Railway Company of England have just built a new kind of mixed traffic locomotive for express goods and excursion passenger traffic. It is of the 2-6-0 type, having six-coupled wheels and a leading "pony" truck instead of a four-wheeled bogie. Except for the wheel arrangement the engine resembles the "County" class of 4-4-0 express engines. The two high-pressure cylinders are outside and are 18½ inches by 30 inches. The boiler is of the standard domeless type of the company, and has a total heating surface of 1,566.74 square feet, and a working pressure of 200 pounds per square inch. The pair of "pony" wheels are 3 feet 3 inches in diameter and the coupled wheels 5 feet 8 inches. The engine in working order weighs 62 tons, and the tender which has a capacity for 3,500 gallons, 40 tons. The engine has something of an American appearance, which is further marked by the Great Western method of having the foot-plate placed much higher above the tender frame than is customary on most lines in this country. Being a mixed traffic locomotive the engine is not named, as are the Great Western passenger engines.

GRAVITY DUMPING CAR OF GENERAL UTILITY FOR A SOUTH AMERICAN RAILROAD

Considerable attention has been attracted to South American railroads of late due to the very large additions which practically all of them have been making to their existing equipment, and particularly through the fact of the distinctively American lines by which the latter is characterized. The management of these various roads have for some little time expressed a decided preference for the American type of locomotive, but not until a comparatively recent date has this same sentiment become also identified with car design. These changed ideas are plainly evident in the abandonment of the rigid pedestals, and the substitution of the four-wheel pivoted truck, the use of steel for bodies, steel for wood underframes, and vastly increased capacity.

The rapid extension of lines which is at present in order in that country necessitates a great number of cars of special type for construction, and considerable experimenting has been done of late with self-discharging hopper ballast cars of various design, with the end in view to secure if possible an arrangement which may serve commercial purposes as well as the actual needs of the railroad.

The Goodwin gravity dumping car herein illustrated is an interesting example of all around utility which was designed to meet the special requirements of the Entre Rios Railway, a British corporation operating about 700 miles of 4 ft. 8½ in. gauge track in the Argentine Republic. It is especially adapted for ballasting, coal, coke or ore service, and has been proved by actual use on many railroads to be thoroughly efficient, and to possess all the advantages claimed for it, which are as follows: It will stand any service which steel hopper cars will stand, it will handle any material which steel hopper cars will handle, it will last longer in service, and it has no cross bracing to interfere with the loading.

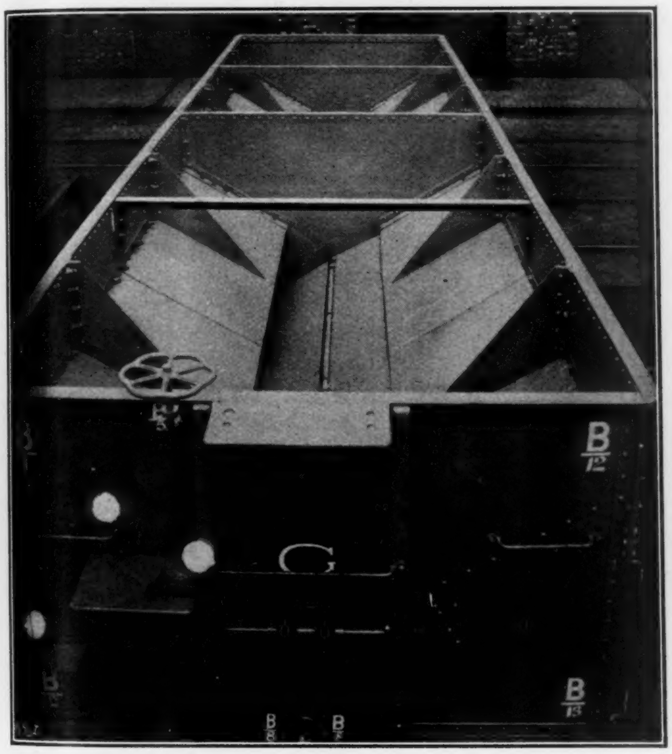


CAR IN RUNNING CONDITION WITH ALL DOORS CLOSED.

In addition, the claim is advanced for this particular design that it will perform the following services which are beyond the range of the ordinary hopper car, viz., it will discharge its load on both sides, or all on either side; all in the center, or part in the center and part on either side, and will distribute ballast in any position required. A special advantage is apparent in the fact that this wide range of distribution can be attained without careening the car, or in fact without any movement of the car body. The design thus combines all the special features of other dumping, ballasting and gondola cars with those that are unique in itself, and it can be immediately diverted to any required service without alteration or change of parts. As an illustration of its general usefulness the Entre Rios Railway advises that it has handled therein, depending on gravity solely, tin slate bars, loose grain, grain in bags, broken stone, large rock, steel billets, coal, coke, pig iron, general ballast, gravel and a variety of other similar material.

The operations for working the doors and chutes for ballast-

ing are clearly shown in the two illustrations herewith. The first shows the car as it appears in running condition, with all the doors closed, and the second is a view of the interior after the whole load has been discharged on one side beyond the rails. The side doors run half the length of the car on both sides, and are opened and closed by means of a spindle and lever. These levers are fixed at each end of the car, and each lever operates the doors on one half of it, thus a small movement causes the doors up to the center to be dropped simultaneously, discharging the load in that section on one side only, or equally on both sides beyond the rails, between them, or partly beyond and partly between the rails at the will of the operator. After the discharge is effected, a similar movement of the lever on the spindle closes the doors. The contents can be unloaded with equal facility while the car is in motion, and in the instance of ballast it can thus be distributed over whatever area may be necessary. The discharging apparatus can also be arranged



AFTER DISCHARGING LOAD ON ONE SIDE.

readily to operate by compressed air or steam, instead of hand levers, or in conjunction with them as desired.

The generally substantial character of the design is clearly shown in the illustrations. The construction is of pressed steel throughout, riveted with exceptional strength, and the workmanship is of exceptional excellence. The smaller photograph shows the arrangement of the interior and of the bracing. The car is divided in the center by a cross bulkhead, which renders each half of it self-contained. This bulkhead is conitnued down to the chute frame or apron piece, and forms the center stiffening diaphragm, visible in the exterior view. The cars have a capacity of 840 cubic feet, with top load, and all parts of the running gear conform to the standard of the Entre Rios Railway. The principal dimensions are as follows:

Length over all, 39 ft.; length over body, 33 ft. 6 in.; width over all, 9 ft. 5 in.; width inside, 8 ft. 10½ in.; and height from rail level to top of side of car, 9 ft. 6 in. The diameter of the truck wheels is 33 in.; truck wheel base, 5 ft. 6 in.; and center to center of trucks, 33 ft. 6 in.

The two cars included in this order which is supposed to be the forerunner of a very large contract, were built by the Gloucester Railway Carriage and Wagon Company, Limited, of England, and were the first of this type to be constructed in that country. It is not known whether bids were invited on them from American firms, but it would seem that in view of the impetus at present associated with car development in South America, and the adoption in that country of types embodying material and constructive features so familiar to car builders of the United States, that it would afford a more promising field than has heretofore been associated with it.

As an instance of the fact that the English firms have gone to untiring effort and great expense to secure this new business it may be mentioned that several have installed very complete plants for the manufacture of pressed steel car shapes, and have extended their facilities to handle cars of this size, which are practically four times as large as any freight car with which they have had to deal heretofore for English railroads.

Harriman Lines Extend Pension System.—The Harriman lines pension system in being extended to the Oregon Short Line has increased the number of pensioners by 23 to whom $519 a month is paid. Operating employees are retired at 65 and clerks and similar employees at 70. Since the department was established the Southern Pacific has pensioned 616 employees. The total amount paid since pensions were established in January, 1903, is $850,607.70, and the disbursements for June on this part of the system was $140,010.35, and for the fiscal year ended June 30, 1911, $168,000.20. At present 420 men and women are on the roll.

Foreign Road Increases Pay.—The employees of the Hungarian state railways had their pay raised on May 1, after years of struggling, which at times was pretty near fighting. They are divided into nine classes. The president now receives $3,000 a year; six directors, $2,400 each; seven vice-directors, $2,000; eight superintendents, $1,800; 115 engineers, $1,000; 430 other engineers, $760; 550 engineers of a still lower class, $580; the three lowest classes, designated only as "employees," $400, $360 and $320. The total number of all classes is 6,039. These are the permanent staff. Probably as many more are employed as laborers, etc., who may be discharged when not needed.

Railless Traction.—The first practical experiment with the railless trolley system in Great Britain was inaugurated recently by the Mayors of Leeds and Bradford, the trial trip being, according to all reports, distinctly successful. Major Pringle officially inspected the system before the function, and the service will be open to the public after the final sanction of the Board of Trade has been obtained. The cars are built to carry 28 passengers. The result of the experiment will be watched with much interest, for there are many proposals at present under consideration for similar service elsewhere.

A Paint Which Indicates Changes of temperature by changes of color is made of a mixture of seven parts of saturated solution of potassium iodide and 134 parts of saturated solution of mercuric chloride with one part of pulverized copper sulphate and the necessary oils and driers. The paint changes its color between 115 deg. and 130 deg. F., and is applied to any surface which it is desirable to know if it is becoming heated. The range of temperature at which color changes take place may be slightly varied by altering the proportions of the ingredients.

Escape Non-Essentails.—Most men have a genius for seeing things as they want to see them; not as they are; and for fixing their attention on non-essentials. To make real progress, such characteristics must be overcome, and the one and only way it can be done is to show how much more profitable is a policy based on scientifically accurate knowledge.—*David Van Alstyne before the Congress of Technology, Boston, Mass.*

A Series of Analyses made of the contents of the ashpans of ninety-five locomotives on the Erie R. R. showed them to contain an average of 33 per cent. unburned carbon. This means that one-third of the total cinders has not been burned, and must represent in the aggregate a very large amount of waste capital.

RECENT DEVELOPMENTS IN DRILLING MACHINES

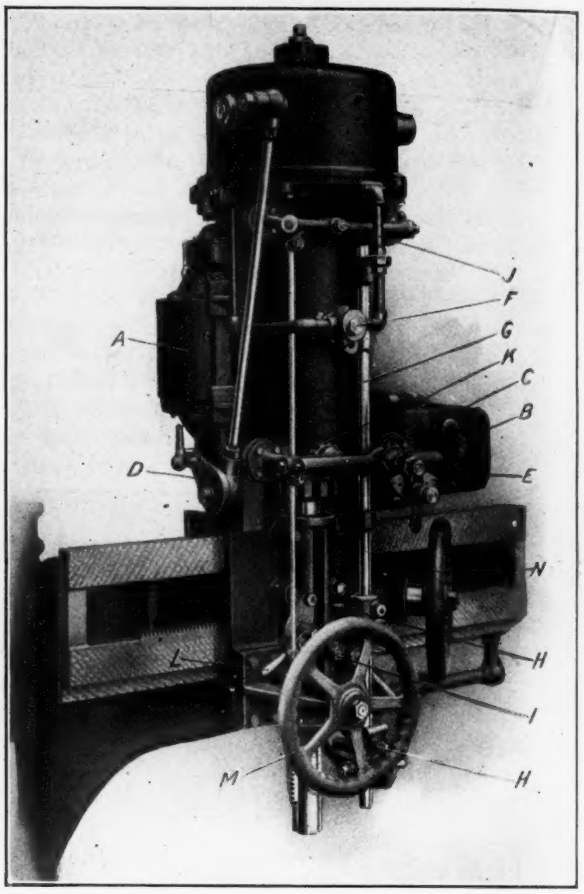
Attendants at the last railway mechanical conventions will remember the exhibit of The Walter H. Foster Co., in Machinery Hall, where there were shown in operation two drilling machines constructed on entirely new principles, one being a radial and the other a multiple spindle machine. The radial drill is of the hydro-pneumatic type and differs entirely in its driving and feeding arrangement from the usual design. The multiple spindle-drill is of the all-geared type, eliminating the use of universal joints. Both of these machines are illustrated herewith.

Hydro-Pneumatic Radial Drill.

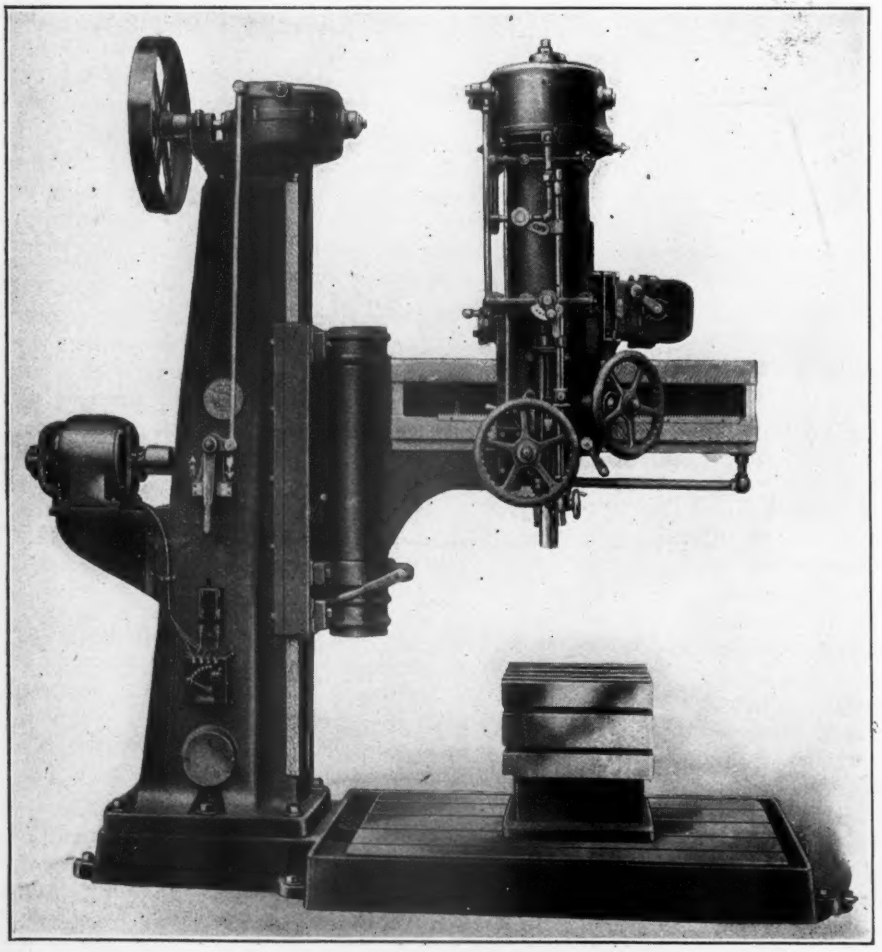
In this design the complete driving and feeding mechanism is confined to the saddle on the arm and the arrangement is such that the two operations are entirely independent, the rotating of the drill being obtained through a geared connection to an electric motor, while the power for feeding is furnished by air pressure. The remainder of the machine is very largely of usual construction, a small motor being provided on the column for raising and lowering the arm. This motor also drives the oil pump for the lubricant.

Briefly, the construction of the operating mechanism consists of a cylinder, forming part of the saddle, around which is cast a concentric chamber of a capacity practically equal to that of the cylinder. Above this is a gear box, through which the motor drives the spindle—the arrangement being for two different spindle speeds for each motor speed. The motor is of the direct current variable speed type and the controller with its resistance is mounted at a convenient location on the cylinder. The spindle passes continuously through the center of the cylinder to the gear box at the top. The piston in the cylinder has a loose fit on the spindle and ball bearing collars are provided above and below it, so that all vertical movement of the piston is communicated to the spindle, but the rotating of the latter does not affect the former. Air pressure from the shop line, which should not be less than 80 lbs. per square inch, is admitted to the cylinder above the piston and furnishes the power for feeding the drill. Below the piston the cylinder is filled with oil and communication provided through a properly designed valve between the cylinder and the surrounding chamber. After the spindle has reached the end of its stroke the air pressure is transferred from the cylinder to the top of the oil in the chamber, thus forcing it back into the cylinder and pushing the piston with the spindle to the top. It will be seen that any desired rate of feed can be obtained by the proper throttling of the oil in its passage from the cylinder and also that a remarkably steady feed can be obtained with the elimination of all back lash with its danger of breakage of drills under such conditions as striking a hard spot or breaking through at the finish of a hole. In case the feeding resistance becomes greater than the total air pressure the spindle will simply revolve and do no damage. An automatic device is provided for shutting off the air pressure at any desired point and automatically returning the spindle.

In the enlarged view of the head the arrangement and construction is shown very clearly. The motor is shown at *A* and the controller of the drum type having ten points of contact, is indicated by *B*. The resistance *C* is attached in a very handy and compact form back of the controller. Lever *D* operates the clutch for the high and low speed gears in the gear box at the top of the cylinder. Feed operating valve



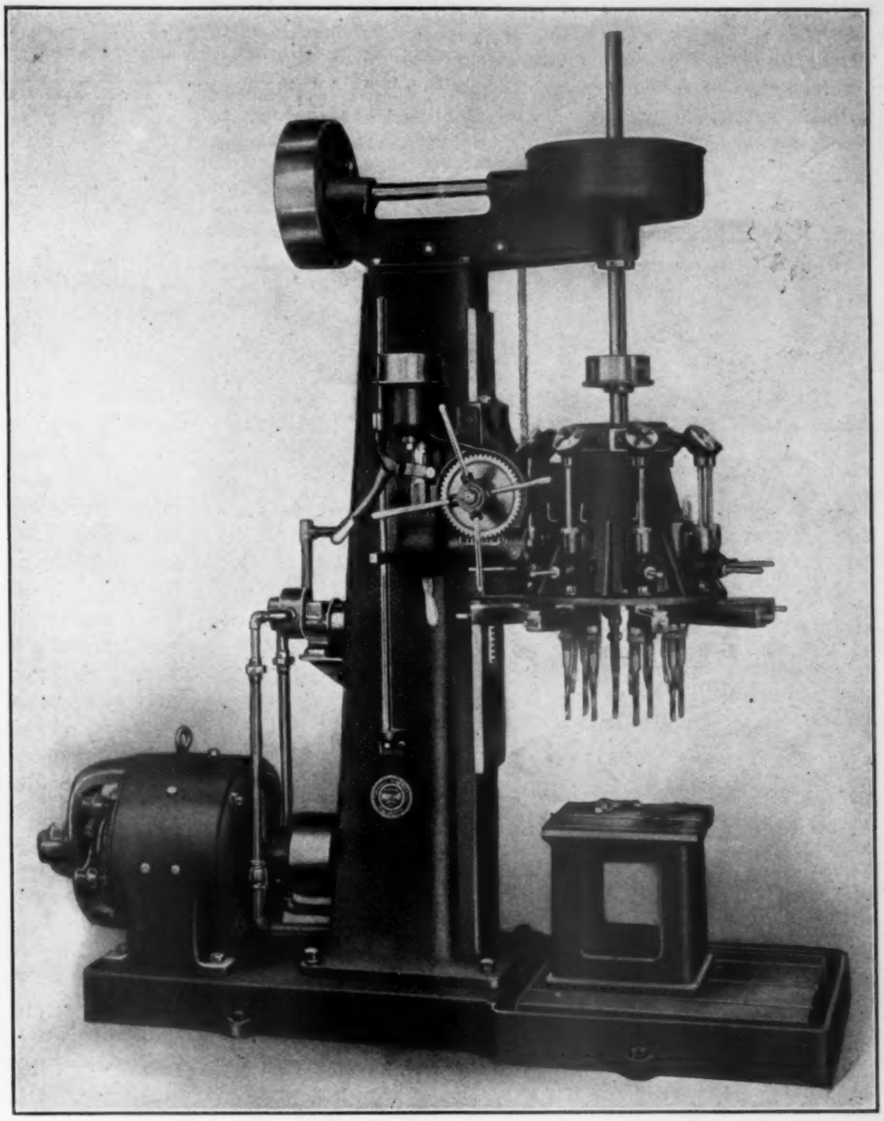
DETAIL VIEW OF THE OPERATING MECHANISM.



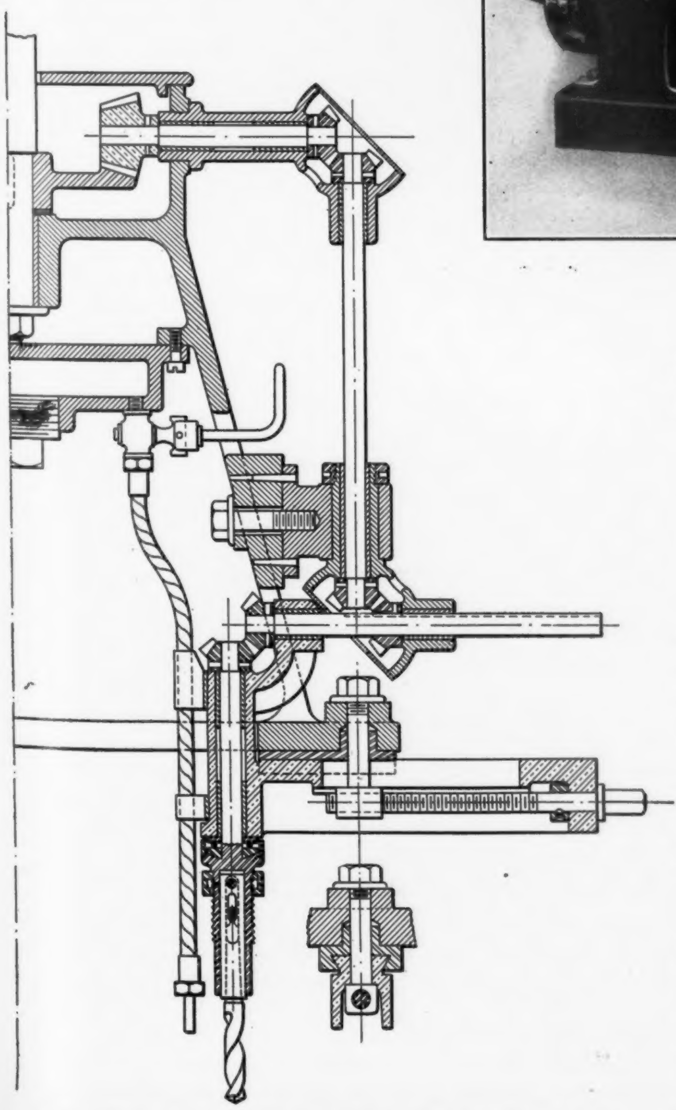
HYDRO-PNEUMATIC RADIAL DRILL.

E has a flat seat and controls the passage of oil from the cylinder to the surrounding chamber and valve *F* controls the passage of the air either to the cylinder or to the surrounding chamber. This is a four-way valve opening an exhaust from one side to the other, as desired. Vertical shaft *G* operates this valve and is provided with adjustable trip dogs *H* arranged to swing out of the way when the spindle is operated by hand. *I* is a tappet on the spindle for striking the dogs on the shaft *G*. Valves *J* and *K* operated by lever *L* permit the air and oil to pass freely in either direction and are used when the spindle is operated by hand, this hand operation being performed by means of wheel *M*. The hand wheel *N* is for moving the head in and out on the arm.

The manufacturers state that the efficiency of this drill is best indicated by the size of motor needed to do the same work when compared with a geared radial drill of the same size. On a geared radial it is stated that to drive the friction load at 330 r. p. m. requires 3.5 h.p., while on the hydro-pneumatic drill under the same condition but .8 h.p. is needed. The working load on a geared drill, using a 1 in. drill, 338 r. p. m., .022 in. feed per revolution of spindle, drilling 7.4 ins. per minute, is equivalent to 30 h.p., while the working load of a hydro-pneumatic drill with the same speed and feeds is but 8 h.p. These drills are now furnished in two sizes, 4 ft. and 6 ft., and it is expected that other sizes will be manufactured later.



ALL-GEARED MULTIPLE SPINDLE DRILL.



SECTIONAL VIEW OF ALL-GEARED MULTIPLE SPINDLE DRILL.

ALL-GEARED MULTIPLE SPINDLE DRILL.

To obtain the same high efficiency in production with a multiple spindle drill that is given by other high speed drilling machines is the object of the new all-geared design exhibited which is shown in the accompanying illustration.

It has been found that the extremely tough high grade alloy steels entering into the construction of automobiles and other high grade work are not capable of being machined in as efficient a manner on the multiple spindle drilling machines in use and at the same time allow the full benefit of the high speed drills to be obtained. These machines were of the universal joint principle, and it was believed that too large a proportion of the power was being consumed at this point, and therefore a design was drawn up which uses gears only. This drill has proved its ability to use high speed steel drills to their full capacity in this class of work.

The machine is so designed that the spindles, of which there can be any desired number from four to sixteen (the machine shown has eight), can be set to drill any lay-out desired within its range, whether circular, square, rectangular, or in a straight line, or in fact any shape needed. The sectional drawing, through one of the spindles, together with the general view of the machine, clearly illustrates how the different adjustments of the spindles are obtained. The whole driving apparatus, connected to the main vertical shaft, is mounted in a steel casting carried in

guides on the column and the feeding mechanism is located at that point. The weight of the head is counterbalanced by a weight inside the column. Arrangements are made for three different rates of feed for each drill spindle speed. All the gears throughout the machine are of steel or bronze hardened where necessary and all bearings are bronzed bushed. The spindles are

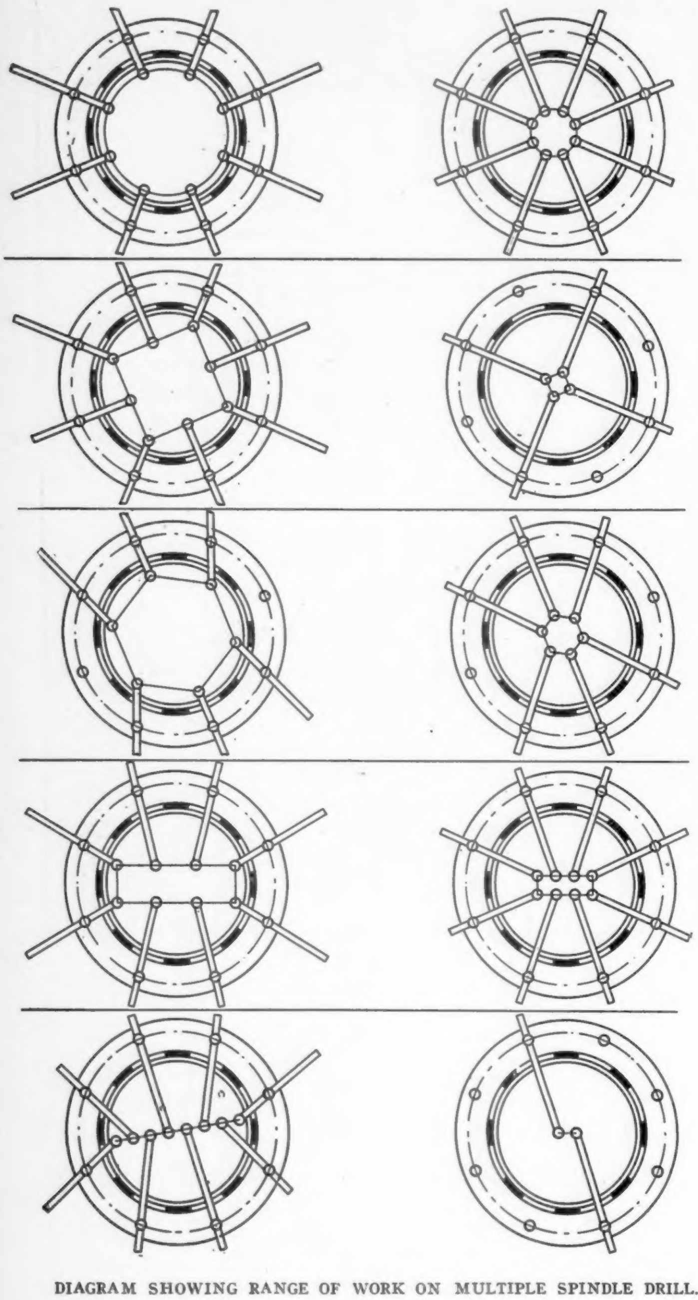


DIAGRAM SHOWING RANGE OF WORK ON MULTIPLE SPINDLE DRILL.

provided with ball thrust bearings and each spindle has an individual oiling arrangement through a flexible tube. The motor is mounted on the base of the machine and drives through a belt. An oil pump with circulating pipes and automatic relief valve is also provided.

GRAND TRUNK PACIFIC EXTENSIONS.—The Grand Trunk Pacific is spending $17,000,000 this year in constructing some thousand miles of new track. It is stated that 10,000 men and 4,000 teams have been engaged. There is keen competition between the Grand Trunk Pacific and the Canadian Northern as to which will first reach the Pacific Coast. Up to the present the grade on the main line has been carried almost to Tete Jaune Cache, a point about 1,100 miles west of Winnipeg, while steel has actually been laid as far as Fiddle Creek, about 80 miles east of Tete Jaune Cache.

CONDITION OF WOODS BOILER AFTER THREE YEARS SERVICE

Three locomotives fitted with Woods firebox and tube plates were put into service on the New York Central lines on Dec. 4, 1908, and have been on regular passenger runs since that time. One now has its third set of flues and on going to the shop recently was given a very careful external and internal inspection by C. J. Chester and Mr. Hennessey, the New York Central superintendent of the boiler department, Depew shops, as well as by Edward Oldman, boiler maker for Farrar & Trefts, who made the boilers, and Fred H. Snell, inspector for Mr. Wood.

The general condition of the boiler was conceded to be much the same as when examined internally October, 1910. The corrugation of firebox forming side and crown was examined very carefully and found free from any defects. It was noted the crown staybolts showed having sweated after dumping of fires. It was found that more effective washouts might have kept crown sheet much freer from cake scale, same as the sides of the firebox which were clean. The back tube plate was examined carefully and tube holes were found round and in good form, not distorted—no cracks between bridges of tubes.

The corrugations on the back tube plate encircling the tubes were carefully examined by the gauges from which they were made and the center bottom was affected by expanding tubes, closing it inward from its shape as much as 3/16 of an inch. This with working under expansion and contraction had caused an extension strain which showed a tendency to crack. There were one or two places in this part where a penknife blade might be inserted 3/16 in., and to the right a line 33 in., to the left one 34 in., no part of which was 1/64 in. deep. This crack part referred to can be fixed by the Oxy-Acetylene welder, therefore it was not considered these would in any way interfere with the working of the boiler until another set of flues are put in, when the same examination can be made again. No cracks were found between bridges of flues or on any part of the back flue sheet except those above mentioned.

From a careful staybolt test it was found that two throat sheet staybolts were broken, one on left first row under radius of throat sheet, and one right, also one stay on each side of firebox at throat sheet end, about at the bottom of radius of firebox crown sheet, also one in right corner of back sheet, and four in third row over center of fire doors on back sheet of firebox. These are the only staybolts to be replaced since last shopping. The mud ring was examined and found tight and in first-classs condition, as well as staybolts on outside, which showed no appearance of leaking on outside wrapper sheet, nor did the rivets of the boiler shell.

The front tube sheet was found in perfect shape with good flue holes and no cracked bridges, the corrugation corresponding with the gauges.

THE UNITED STATES LEADS THE WORLD in telephonic communication, there being one telephone for every twelve and one-half inhabitants in the country. Canada ranks second and Sweden third, on this basis. It is also an interesting fact that New York City alone has as many telephones as Germany. Ohio has as many as Great Britain; Chicago more than London, while Boston has double the number of telephones in Paris. In all of Europe with its twenty-six countries there are only one-third as many telephones as in the United States.

MILEAGE OF CHINESE RAILROADS.—There are more than 4,150 miles of railroad in operation in China, and of that mileage the Chinese have 1,128 miles, and in combination with British capital 708 miles more. The Russians built 1,088 miles in Chinese territory when they counted upon making Manchuria a part of the Russian empire. The capital for the remaining road came from Great Britain, Germany, France, Japan, Belgium and the United States—thirty miles being the meager American share.

FRAME WELDING AND REPAIRING

At the Nineteenth Annual Convention of the International Railroad Master Blacksmiths' Association held in Toledo, O., July 15-17, a number of excellent papers were read and were discussed with the same animated spirit which has always characterized the meetings of this body. The various timely questions of tools and formers, drop forgings, flue welding, frame welding, case hardening or carbonizing, piece work, spring making and repairs, high speed steel, and special welding and threading steel were presented in turn, and their consideration has added many valuable items to existing information.

The subject of frame welding is probably of greater interest at this time and the views of J. G. Jordan (T. & N. O.) may be regarded as of some significance. Mr. Jordan said in part as follows:

Repairing frames of engines in roundhouses is a makeshift job, and always will be. You cannot get stock enough in each end of the weld, and the frames will waste away in making your heat, no matter what you heat with—gas, oil or thermit,

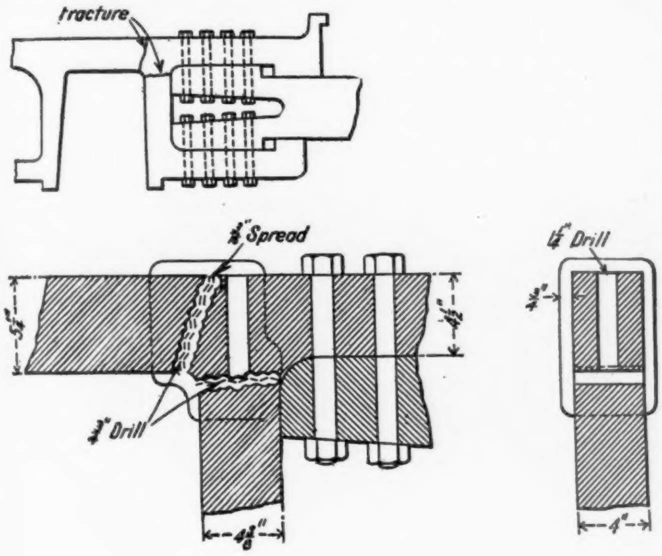


FIG. I.

but we have to weld them in the roundhouse to keep the engines in service. At present we are welding with thermit. I think it is the best temporary job you can make. A molder is broken in for this class of work, and he makes his own mold and does all his own work, except when taking off the heat, at which time he is assisted by a helper. Of course, there are many cases where the frames cannot be welded in the roundhouse; when they break under or near the firebox or under the cylinders. In repairing frames on the anvil we always make the "V" so that the grain of the iron is parallel with the frame, and we use good iron and coal, a good heater and plenty of stock.

Objection was taken to Mr. Jordan's statement that welds made with the frame in place were makeshifts. If the proper precautions are taken there are no good reasons why such welds should not be a success. If is, of course, less convenient and more difficult than working on an anvil, but it is far more satisfactory from the standpoint of cost—both for the actual work done, and the time of keeping the engine out of service. It is not necessary to use collars with the thermit weld. If the frame is properly heated before welding with thermit there should be no trouble in getting successful results.

In this connection G. W. Kelly (C. R. R. of N. J.) said that thermit was used by him in making repairs to frames under the engine. The accompanying sketch, Fig. 1, illustrates a difficult compound weld which was made recently in the roundhouse at Elizabethport, N. J. The 1¼ in. hole is drilled through the top rail to give the thermit a better opportunity to circulate, and to permit the frame to preheat more uniformly. The pedestal jaw was spread apart 3/16 in. Formerly, when the leg was broken from the top rail of the frame these welds gave trouble and two or three failures resulted, but since the 1¼ in. hole has been used through the frame into the break, allowing the thermit to circulate around the frame and through the hole, there have been no failures. Mr. Kelly commented further as follows:

To prevent the frame from upsetting while preheating and welding, we expand the opposite frame with a slow charcoal fire. When a frame is broken in two or more places in the front pedestal and the engine requires general repairs the broken pedestal is replaced by a steel one which is already machined.

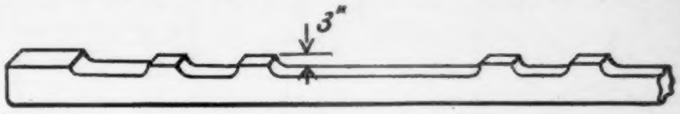


FIG. 2.

Some of these require three welds, as this type of pedestal is welded to the front end of the frame forward of the guide-yoke, thus cutting out the splice and making a continuous frame.

The writer has been asked: "Do you consider thermit welding permanent, and will the weld hold during the life of the engine?" Since August, 1906, we have made 186 welds on four different classes of engines where it was necessary to apply new steel front pedestals. Of the above welds we have had but one failure, which was due to unequal contraction. During the last six years we have made many welds at various places on steel and wrought iron frames, driving wheel centers, and steel braces, etc., which have given us no trouble. We have found it very beneficial to keep a record of the welds made and the conditions at the time of making them, so that should a failure occur, by looking up the record we can generally locate the reason.

H. D. Wright (Big Four) presented a very interesting contribution on the general subject of both frame repairing and making, saying in part:

In making a frame the frame is blocked out ready for the limbs and braces to be welded in place, as shown in Fig. 2. The lugs should not exceed 3 in. in height, and by this method you will avoid having any cross-grained iron in the frame legs when the limbs are welded on. Fig. 3 shows how the limbs should be forged and scarfed ready to weld on to the frame back. The boss that is left on the limb for the braces should not exceed 2½ in. in height. Before these parts leave the forging hammer, they should be scarfed to an angle of 45 deg. by the use of a V-block and fuller. Then weld the limbs to the frame back in one heat. I prefer to put the frame leg on in one heat, even though the outside scarf does show a little, rather than to have the second heat taken and the center of the iron loosened up by not heating through to the center. It does not do any good to weld up the outside solid and then take it to the planer and plane it all away, and there are certain heats that open a weld very easily when working. For example, take two pieces of 2 in. by ½ in. iron, bring them to a good welding heat and lay them down. You will find it a difficult matter to pull them apart when cold.

Take the same two pieces of iron, if you have not pulled them apart, put them in the furnace and bring them up to a greasy heat and you will not have any trouble in separating

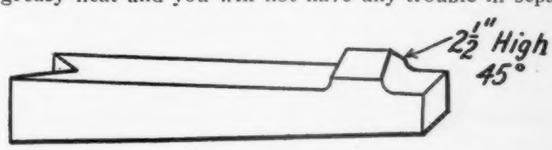


FIG. 3.

them. The same condition is true in frame work, and while you may have trouble to get the men to make a weld in one heat in a day work shop, we have no trouble on this score from men working piece work.

The method of putting in the bracing, commencing at the back end of the frame, is shown in Fig. 4. *A* shows the position of the brace before the hammer makes the weld, and *B* is the finished weld. Cut away the extra metal between the frame brace and back as shown by dotted line with a gouge. This method will make a sound weld, but care should be exercised that the bevel on the frame back has the correct taper, so that when the hammer strikes it, it will be driven into place. The brace *C* is made of two pieces of 4 in. x ⅞ in. iron bolted fast to the back and the holes are spaced the correct distance to allow the brace to slide into place. When the brace is put in place ready for welding it will stand away some distance from the limb; as a rule we put a block of soft wood between the brace and the limb with the grain running the right way so that when the brace begins to draw the block will split, allowing the brace to come back into position.

Fig. 5 shows the lower rail pieces in place. They should be welded first at *A* and *B*, and then at *C* and *D*. By this method you reduce the strains that come on the legs and a few blows of

the hammer on the braces after the weld is made will further remove them. The proper place to strike the braces is indicated by the arrow heads on the sketch. The front end as used on

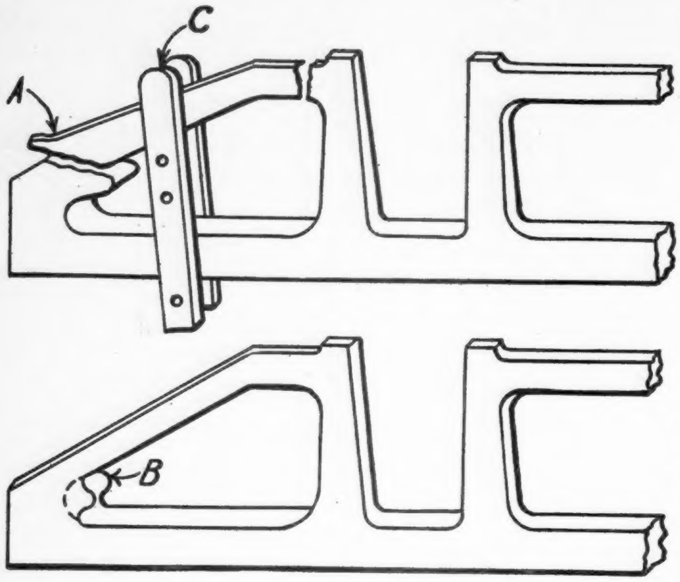


FIG. 4.

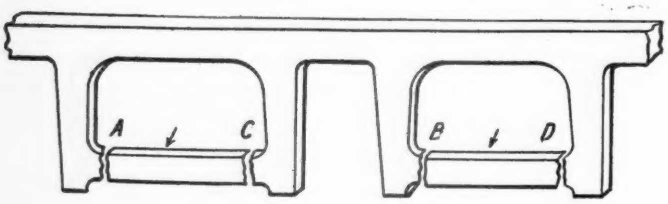


FIG. 5.

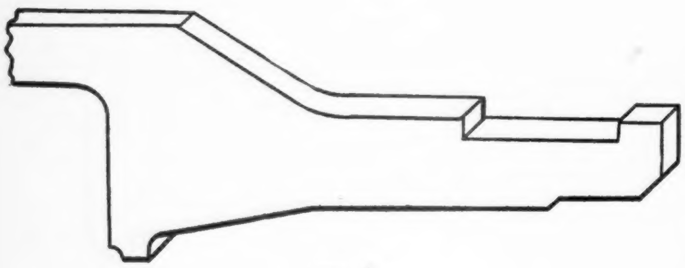


FIG. 6.

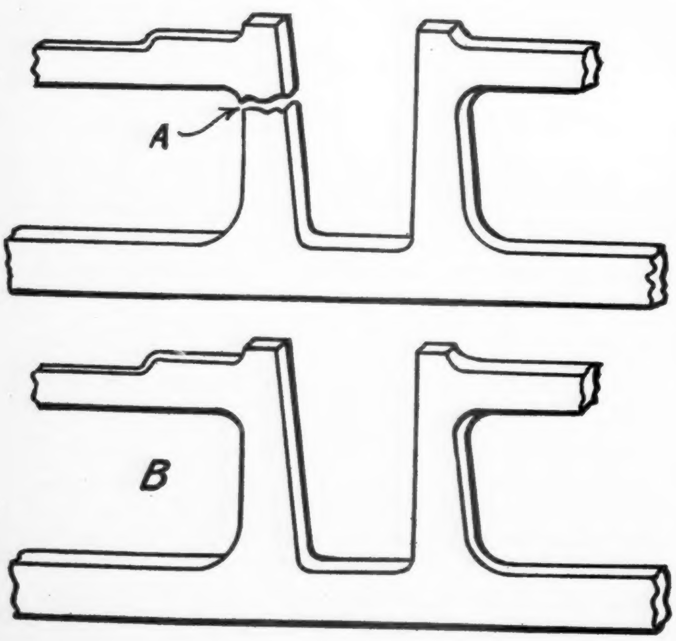


FIG. 7.

some of our heavier engines is made in one piece under the hammer and is shown in Fig. 6. This type of front section is finished in the machine shop and drilled before it is welded to the frame.

The type of front limb that is ordinarily used is shown in Fig. 7, and *A* shows the part ready to weld in place. Weld a small stub on the frame back and then weld on the front limb. In making the offset frame shown in Fig. 8, the back is made in two pieces, and is then welded at *A*, after which the work

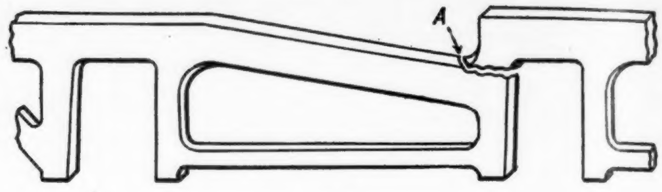


FIG. 8.

is handled in the same way as if it were a straight back. In repairing frames, I scarf all my work on a 45 deg. angle. The component forces are thus equal and the wedge will not take any more of the blow than the scarfed frame piece. The parts will thus weld thoroughly from the point to the outside of the frame.

In repairing frames under engines we make all our own preparations and do not call on the machine shop for any help whatever. We have had only one frame that had to be sawed out by a machinist and that was due to the weld being right against the firebox. The type of weld which we use is shown in Fig. 9. In heating the frame member for the purpose of cutting out or welding, we build a brick furnace around the fracture and use fuel oil burners, one on either side. One burner is below the

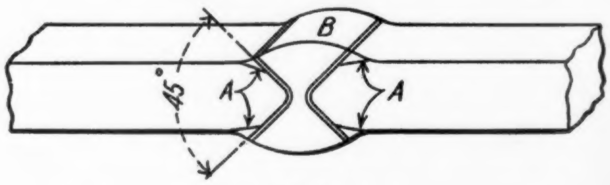


FIG. 9.

fracture and the other above it. This allows the flames to make a circuit around the frame and to heat it up evenly. In building the furnace we always leave two or three bricks on each side so they can be taken out without disturbing the rest of the bricks. This method often saves a great deal of time, for if the weld is not made perfectly on the first heat the bricks can be replaced and another heat taken.

In preparing the frame for welding, we cut it out on a 45 deg. angle and then warm up and spring it apart 5/16 in. or 3/8 in. We then cut in at point *A* and drive in four wedges to bring up the stock to allow for wasting in welding. The large wedge is then made and is driven into place making a tight fit. When the frame is brought to a welding heat the loose bricks are removed from each side of the furnace and the rams are used. I have successfully welded 136 frames under engines in this way during the past three years.

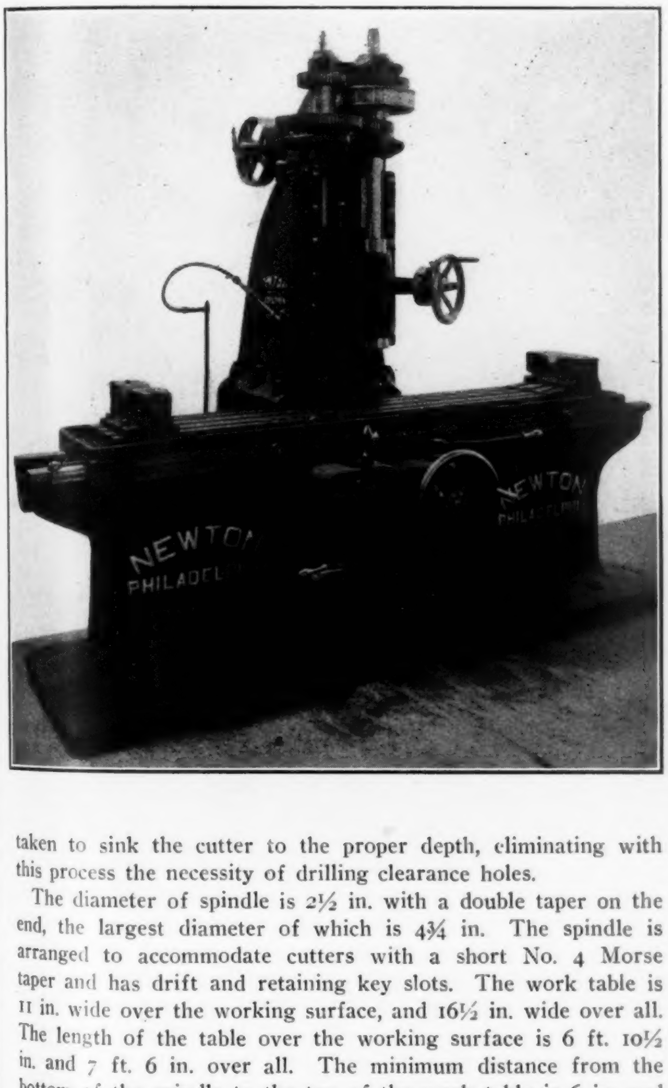
Progress in Steel Car Construction.—At the beginning of this year there were about 3,000 passenger cars in service in this country, built of all-steel construction. The total number of passenger coaches is about 54,600, so that the number of steel cars is about 5.3 per cent. of the total. Of the cars constructed during the present year, 62 per cent. will be all-steel construction, so that at the end of this year fully 9.3 per cent. of all passenger cars will be of steel, while 3.5 per cent. have steel under-frames. The percentage of wooden cars in service has dropped in the last three years from 98.2 to 87.2 per cent.

Another Trans-Andine Railway.—The Argentine Government has just approved of the plans for a narrow gauge line starting from the village of Tinogasta, in the Province of Catamarca and running as far as the Chilian frontier, at San Francisco. The line will cover a distance of 252,743 miles, and the estimated cost is $8,122,460. At San Francisco the line will connect up with the branch line of the Copiapó on the Taltál Railways, both in Chile, thus forming a transandean line.

NEW DESIGN VERTICAL KEYSEAT MILLER

This machine has been developed by the Newton Machine Tool Works, Inc., of Philadelphia, Pa., to displace their former vertical and horizontal spindle machine, the experience of the builders proving conclusively that by use of the special two lip cutter much better time can be made when milling feathered keys of average length. The figures in this connection are interesting, as in ordinary work in the Newton shop the following average rate is maintained: 1/4 in. keyseats, 4 in. long, time four minutes and forty-five seconds; 1/2 in. keyseats, 4 in. long, time four minutes and thirty-five seconds; 5/8 in. keyseats, 4 in. long, time four minutes and thirty-five seconds; 1 in. keyseats, 4 in. long, time seven minutes and ten seconds.

The time here given represents the time required to finish these keyseats after the piece has been clamped in the V-block and includes raising and lowering of the head preparing to shift for another keyseat. The time in seconds represents the time taken to sink the cutter to the proper depth, eliminating with this process the necessity of drilling clearance holes.



The diameter of spindle is 2½ in. with a double taper on the end, the largest diameter of which is 4¾ in. The spindle is arranged to accommodate cutters with a short No. 4 Morse taper and has drift and retaining key slots. The work table is 11 in. wide over the working surface, and 16½ in. wide over all. The length of the table over the working surface is 6 ft. 10½ in. and 7 ft. 6 in. over all. The minimum distance from the bottom of the spindle to the top of the work table is 6 in. and the maximum distance is 18 in. The spindle speeds with 425 revolutions to the countershaft range from 1,194 to 430 r.p.m. with the back gears out and from 395 to 142 r.p.m. with the back gears in. There are nine changes of gear feed ranging from .115 in. to 10.09 in. per minute. The machine, when belt driven, is furnished with a cone having steps 9 in., 11 in., 13 in. and 15 in. in diameter and each 2¾ in. face. The machine occupies a floor space over all of 8 ft. 6 in. by 7 ft. As a standard, this machine is furnished with a table 4 ft. in length having an automatic feed in either direction of 36 in., but the particular machine illustrated is arranged to feed 6 ft.

The spindle revolves in bushed bearings, and has provision for taking up wear. It is driven by a runabout belt, either direct or through back gears, and is provided with micrometer measurement. Square lock bearings are provided on the saddle to the upright, and the adjustments are made by taper shoes. The work table is surrounded by an oil pan; the feed is obtained by means of a screw and revolving nut; the table has square lock bearings on the base; adjustment is made by taper shoes and the feed is available in either direction. There are nine changes of feed, hand adjustment and pump, piping and attachments for lubrication are furnished, the tank for which is in the base of the machine.

The V-blocks furnished are fitted with auxiliary parallels to accommodate the varying diameters and one of the blocks is mounted on a taper base to permit of raising it when operating on shafts having different diameters. In this photograph it will be noted the long helical spiral milling cutter supported at the bottom by an auxiliary support. This provision is made to handle elongated slots in shafting for hoisting machinery and particularly for locomotive piston rods, as it has been demonstrated to be a much more rapid and economical method of doing this work. The operation consists of drilling first a hole through the work the width of the keyseat, placing the shafts in the V-block and passing the cutter through to the bottom support when the feed is taken. On piston rods a special vise is furnished, permitting of the elevation of the work to obtain the one angular end.

These machines are in very successful operation and as average practice it may be mentioned that 13/16 in. diameter keyseats, 4 in. long, are being milled at the rate of 13/16 in. per minute. In addition to the work mentioned, a number of these machines are in use in keyseating locomotive axles and are said by the different firms to be the most rapid machines ever used on this work.

There is one particular advantage in sinking the cutter to the full depth, and then taking the feed, and that is that the bottom of the cutter can be made a little larger, insuring correct size and perfect fit at the top of the shaft on the key.

PIECE WORK IN THE BLACKSMITH SHOP

In discussing this subject at the convention of the Master Blacksmiths' Association, Henry Mangeot (C. H. & D., Cincinnati, Ohio) said:

"About 14 years ago only about 1 per cent. of the work in the railway smith shops throughout the country was being done by piece work. This has gradually increased until I think it would be safe to state that there is about 65 per cent. of the work being done on a piece work basis in these shops to-day. It has been demonstrated that not only is the employee benefited, but the employer also. I have in mind a certain shop that had sixteen fires in operation and was scarcely able to keep up with the average output of locomotives. Piece work was installed on a small scale. The men did not seem to exert themselves much harder than before, but they made every move count. It was unnecessary for the foreman to get after a man for taking two heats when one would answer the purpose. It was to the man's advantage to see to that part of the work himself and not make any unnecessary work, for it would decrease his net earnings per day.

"The hand tools whch belong to the smith in a piece work shop are kept in a much better condition than those in a day-work shop. His tongs, cutters, punches, etc., are well looked after and cared for. The shop referred to above was working sixteen fires before installing piece work; to-day it has only eleven fires and produces more work than formerly. The same foreman is supervising the shop with practically the same class of men he had in the start. There were some lazy mechanics that could not keep up with the pace who were compelled to step down and out; there is no question but that piece work rids the shop of drones, as you will find the average piece worker is a hustler.

"When a man can work with his head as well as his hands

ing piece work, he will naturally take to it. It has been my experience that when a man once gets a taste of working piece work you generally have trouble on your hands when you ask him to work day work. The piece work inspector should be a diplomat, a close observer and by all means fair and honest. A dishonest piece work inspector is a dangerous man to have around. This man generally fills a position of assistant foreman in a blacksmith shop and is among the men at all times, checking them up and inspecting their work and giving such orders as may be in his line.

"I believe it can be more satisfactorily worked in a large shop that does a great deal of manufacturing, as one man can be assigned to making some particular line of forgings. It can, however, be handled in a shop no matter how small: you may have a variety of different classes of work each day, and it is of course a little more difficult to work piece work than in the larger shop. Piece work and shop kinks go hand in hand. Take a piece work shop with a nice collection of shop kinks, and it is surprising to see the output that can be turned out per smith. There should be a liberal appropriation set aside for the tool room for making shop kinks for blacksmith shops.

To MAKE GRANULATED BABBITT METAL melt the babbitt in a ladle, remove the ladle from the fire, and allow the metal to cool. When it begins to "set," stir briskly with a stick until it has all cooled into a granular mass. If any particular size of grain is desired, the metal may be sifted using two screens, one of the desired size mesh to remove the large grains and one slightly smaller to allow the escape of the fine grains.

To ASCERTAIN THE DIAMETER AND PITCH of the thread in a nut or a tapped hole in a casting or forging, particularly if it is a small one, some tap makers cast an expanding metal into the hole and then unscrew it. By reinforcing this with a small square piece of steel set in the hole before casting this can be unscrewed without difficulty. A good expanding metal is bismuth 2 parts, lead 1 part, and 1 part of tin.

STOCKBRIDGE TWO PIECE CRANK MOTION

All Stockbridge shapers are equipped with what is known as the Stockbridge patented two-piece crank moton, a special feature which gives to these machines an unique position and adds to their productiveness by reason of the even cutting speed obtained the entire length of the cut and the quick return. With the regular crank the speed must necessarily increase through the center of the stroke, and of course only that amount of cut can be taken that the tool will stand at its fastest speed. In this two-piece crank motion it will be readily appreciated from a study of the details that the speed is uniform.

The two-piece crank is a very compact arrangement, as the illustrations show, and its action, which may be clearly noted therein and in the diagram of the velocity curve, is most interesting.

Referring to the photograph showing the beginning, center and end of the cutting stroke, Fig. 1 shows the parts in their relative position, just as the ram is to start forward on its cutting stroke. In the following explanation it should be borne in mind that the gear is traveling at a constant speed all the time, and the position of the various parts should be carefully noted, particularly that the eccentric ring (E) travels around the eccentric (C). The latter does not move, but is keyed to the main bearing hub (D).

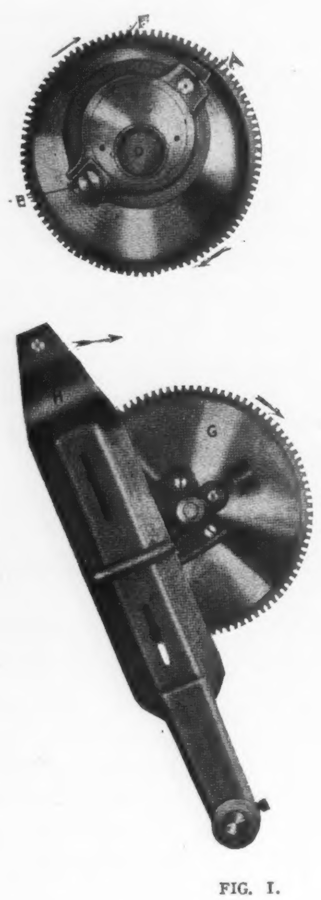


FIG. 1.

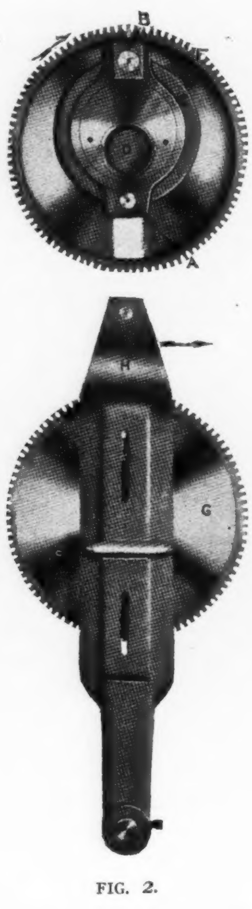


FIG. 2.

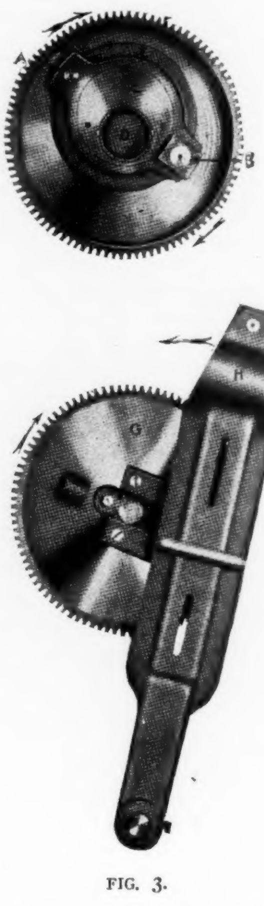
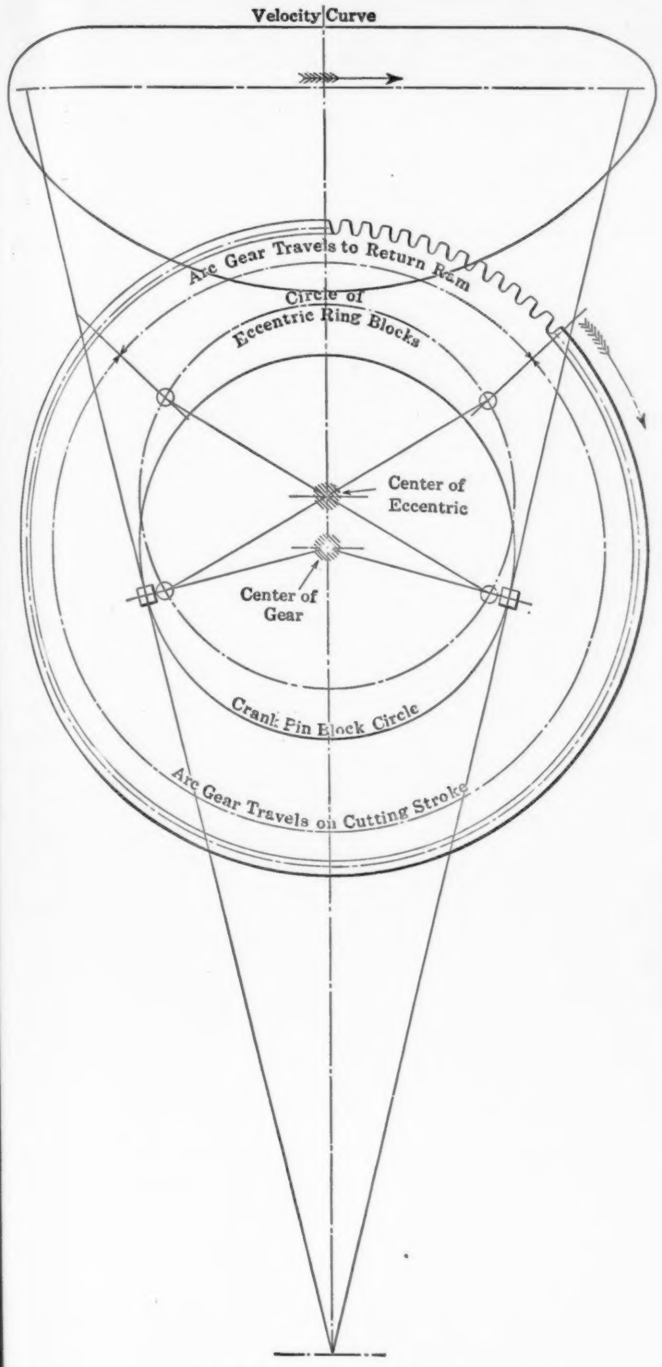


FIG. 3.

In Fig. 2 the rocker arm is shown in an upright position, which means that the ram has traveled one-half the length of the cutting stroke. By comparing positions shown in Figs. 1 and 2 the movement of the various parts can be followed, bearing in mind that the gear travels at a constant speed all the time. It will be noted that the eccentric block (A) has traveled from its original position as shown in No. 1, about 135 degrees of its entire circle. The eccentric ring crank block (B) which is diametrically opposite (A) and connected with it by the same piece, that is—the eccentric ring (E)—must have also traveled an equal arc of its circle, about 135 degrees, bringing it to a vertical position. The eccentric ring crank block (B) and crank pin block (I) are always in the same relative position; that is, and make from fifty to seventy-five cents more a day by work-

the position of the rocker arm can always be determined by the position of the eccentric block (B) or *vice versa*.

In Fig. 3, showing the end of the cutting stroke, it will be seen that the eccentric block (A) has moved approximately 135 degrees from its position in Fig. 2—the ram having reached the



VELOCITY CURVE—ILLUSTRATING STROKE.

end of the cutting stroke. The eccentric block has then traveled 270 degrees from its original position in Fig. 1; that is, the ratio of quick return is the distance (A) travels in returning the rocker arm from its position in Fig. 3 to that of Fig. 1; in other words, to the complete circle.

This may be better illustrated through the velocity curve. The number of teeth in the arc which the eccentric block travels to return the ram is to the whole number of teeth in the gear, which is 96, as 3.27 is to 1. This represents the actual quick return ratio for this particular size shaper. The power that is put into the shaper acts equally on every tooth of the gear, and that put into the Stockbridge, on the cutting stroke, is acting on more teeth, or for a greater length of time, as expressed by the quick return ratio, than is possible on a regular crank shaper. The circle which the eccentric ring blocks make in traveling around with the gear has a radius constantly varying from the center of the gear. It is this feature of varying distance that compensates for the varying speed of the regular crank shaper ram and gives to the Stockbridge an even cutting speed the entire length of the cut—the speed coming up gradually and reaching a maximum, remaining so to the end of the stroke where it drops off gradually just before reversing.

The following table shows the ratio of the Stockbridge 24-26 inch shaper. Note the high ratio of return on ¼ length stroke and this ratio is maintained even down to one inch stroke.

On	full	length	stroke	3	: 1.
¾	"	"	"	13	: 5.
½	"	"	"	16	: 6.
¼	"	"	"	31	: 14.

The following interesting test was made at the Worcester Polytechnic Institute by H. P. Fairfield:

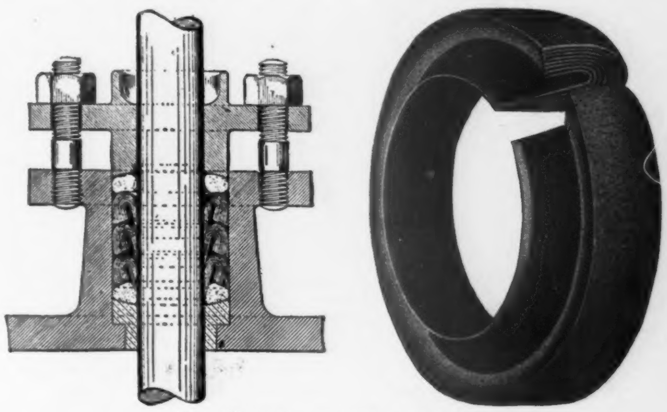
	Regular Crank Motion.	Stockbridge Crank Motion.
Depth of cut	¼	¼
Length of cut	12	12
Length of stroke	13	13
Feed per stroke	.0588	.0588
Cutting speed feed per minute	22	22
H. P. required	4.69	3.76

The patented two-piece crank motion showed in the above test a saving of 20 per cent. in power.

A NEW PISTON PACKING

Announcement has recently been made by the H. W. Johns Manville Co. of New York that it has secured control of the American rights for a successful English piston rod packing, which is called "Sea" rings.

This packing, shown in the accompanying illustration, is moulded of laminated material, either asbestos, flax or duck, depending upon the service, in the form of a wedge with the thin end turned inwards, leaving a hollow space in every ring between the lip and the heel into which steam can flow and force the thin edge against the rod. It is readily observed that when



"SEA" RING PISTON PACKING.

there is no pressure against the packing, as on every alternate stroke, the packing bears very lightly against the rod, but when pressure is placed on that side of the piston the packing holds with the pressure proportionate to that in the cylinder. The tightening up of the gland is not required to the extent necessary with soft packing, since all that is necessary is to hold the rings in place and the pressure of the gland is not required to prevent leakage.

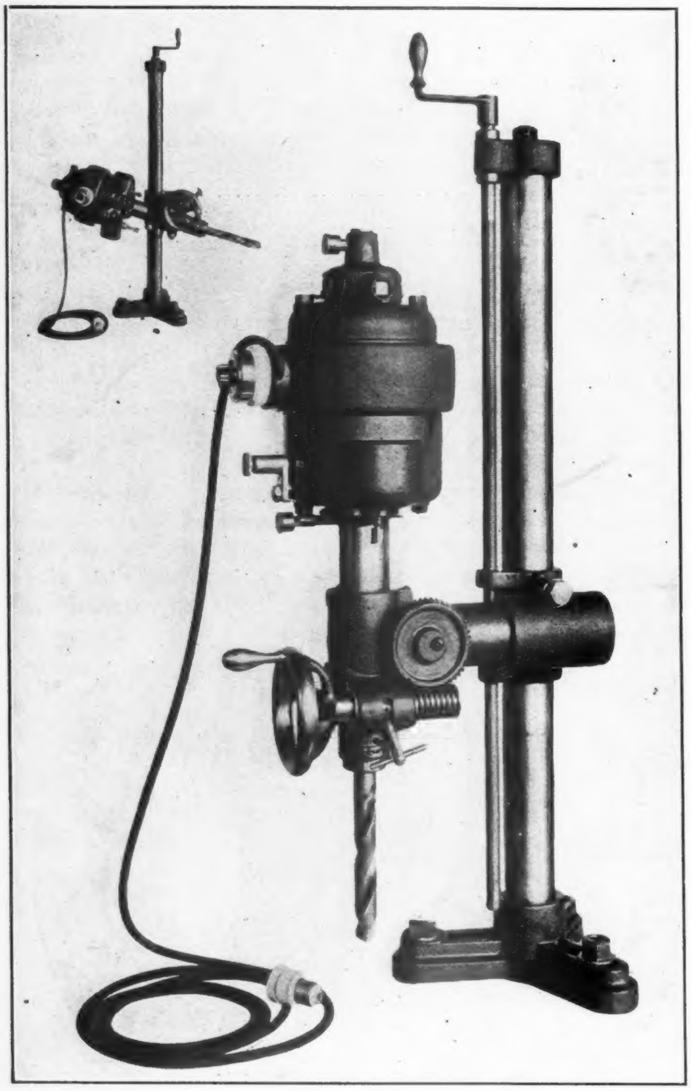
The advantages advanced for this form of packing are less wear on the rod; pressure against the rod proportionate to the tendency to leak, ease of application and long life. The rings will stand a temperature of 600 degs. F. and have been found thoroughly satisfactory for steam hammers, air compressors, engines, as well as for pumps of all kinds, to which they are particularly adapted.

It is Proposed to Hold a Smoke Abatement Exhibition in London next spring. The exhibition, which is being arranged by the Coal Smoke Abatement Society, will be held at the Royal Agricultural Hall, and will last a fortnight.

A PORTABLE ELECTRIC RADIAL DRILL

The very efficient portable electric drill herewith illustrated has been recently placed on the market by the Lamb Electric Company, of Grand Rapids, Mich. The machine will bore holes up to one inch diameter in any position. Its extreme height is 40 in. and the greatest distance from the spindle to the base 28 in. The total weight of the drill is between 130 lbs. and 150 lbs., according to the kind of motor used.

The illustration well depicts the universitality of the machine It may be clamped to the work if desired, and when once



clamped is ready for use, the adjustment necessary being the raising or lowering of the drill by the handle at the top, rotating about the steel column or rotating about the drill arm. It will save considerable time on large heavy work that cannot be conveniently handled by large radial drills.

The largest drilling radius is 8¼ in., but any of these limitations may be made greater to suit conditions. The column is made of steel tubing, 2½ in. diameter. The spindle has a socket for a No. 3 Morse taper, and has a travel of 5 in. by means of a rack and pinion which may be operated by the hand wheel or by power through the worm and wheel as shown. The machine may be equipped with a quick return when so ordered. If desired, two speeds will be furnished and the change from one to the other may be made instantly by the shifting of a knob.

IT IS BELIEVED that within five years the subway lines of Greater New York will be carrying 800,000,000 passengers per year.

WENTWORTH INSTITUTE

There has just been opened in Boston a new industrial school made possible by the will of Arioch Wentworth, who left over $3,500,000 to endow a school to furnish education in the mechanic arts. This school is intended primarily for young men who are already employed and also for those who wish to train themselves for either manufacturing or building trades with some practical skill at the start.

Both day and evening courses will be offered, the day courses being of two types, short one year courses and more thorough two year courses. The first are but six dollars per term for day students and six dollars for the season of two terms for evening students. Part time courses are also offered, which require students to attend classes at the institute every other week.

The equipment already provided is of the highest class and very carefully selected for its purpose. It is intended that one-half of the time of the student shall be devoted to practical work in ideal modern shop conditions, the other half being instruction or laboratory work.

Arthur L. Williston, for many years the head of the School of Science and Technology of Pratt Institute, Brooklyn, N. Y., has been selected as principal of this school.

PERSONALS

A. A. McGregor has been appointed assistant master mechanic of the Louisville & Nashville Ry. at Evansville, Ind.

V. M. Sisk has been made master smith of the Baltimore and Ohio R. R. at Pittsburg, Pa., vice George Judy, resigned.

D. W. Cross has been appointed acting master mechanic of the Toledo, St. Louis & Western Ry., with office at Franklin, Ind.

William C. Weldon has been appointed purchasing agent of the Colorado Southern R. R., with headquarters at Denver, Colo.

I. L. Ulrey has been appointed foreman of the air brake department of the Chicago & Eastern Illinois R. R., with office at Oaklawn, Ill.

A. S. Abbott, master mechanic of the Frisco system at Sapulpa, Okla., has been appointed mechanical superintendent of the First district.

Edward Huges is now purchasing agent of the Lehigh & New England Railroad, headquarters at Lansford, Pa., J. B. Whitehead having resigned.

F. E. Bates has been appointed assistant superintendent of locomotive fuel service of the St. Louis & San Francisco Ry., with office at Francis, Okla.

M. Dailey has been appointed master mechanic of the Bellingham Bay & British Columbia Ry., with office at Bellingham, Wash., succeeding W. J. McLean, resigned.

P. H. Reeves, motive power inspector of the Baltimore and Ohio Southwestern Ry., has beeen appointed master mechanic at Chillicothe, O., vice George F. Hess, resigned.

P. C. Moeller has been appointed night roundhouse foreman of the Rock Island Line at Silvis, Ill., vice J. Fitzgerald, transferred to the Forty-seventh street shop, Chicago.

F. M. Gilbert, mechanical engineer, New York Central and Hudson River Railroad, has resigned to become assistant general superintendent of the New York Air Brake Co. at Watertown, N. Y.

William E. Rockfellow, general car foreman of the New York Central, has been appointed superintendent of the car department of the St. Lawrence and Ontario divisions; office at Oswego, N. Y.

H. Weitzel has been made master mechanic of the shops of the Southern Pacific of Mexico at Empalme, Sonora, Mex. He was formerly superintendent of those shops, which position is now abolished.

T. T. Cloward, foreman of locomotive repairs of the Philadelphia, Baltimore & Washington R. R., at Bay View, Md., has been appointed general foreman of the Wilmington (Del.) machine shops.

Walter Coon has been made master boiler maker of the New York Central at W. Albany, N. Y., vice G. W. Bennett, resigned to become district federal boiler inspector of District No. 3, office at Albany.

H. Marsh, general car foreman of the Baltimore and Ohio Southwestern Ry. at Washington, Ind., has been appointed general car foreman of the Iowa Central at Marshalltown, Ia., vice W. E. Looney, resigned.

W. O. Thompson, master car builder of the New York Central at East Buffalo, N. Y., has had his authority extended over territory west of Syracuse, including the St. Lawrence, Ontario and Pennsylvania divisions.

H. A. Witzig has been appointed master mechanic of the Missouri Southern Ry., in charge of shop and rolling stock, with office at Leefer, Mo. Mr. Witzig succeeds Thomas Goulding, resigned to accept a position with the Chicago, St. Paul, Minneapolis & Omaha Ry.

W. H. Donley has been made master mechanic of the Illinois Central R. R. at E. St. Louis, Ill., vice F. G. Colwell, resigned to become master mechanic of the Delaware, Lackawanna & Western R. R. at E. Buffalo, N. Y.

John Forster has been made mechanical superintendent of the St. Louis & San Francisco, with headquarters at Springfield, Mo. Mr. Forster for eleven years has been master mechanic of the Kansas City division of that road.

G. E. Carson, master car builder of the New York Central at West Albany, has had his authority extended and is now in charge of the territory east of Syracuse, including the Hudson, Harlem and Putnam divisions.

C. D. Young, assistant to the General Superintendent of Motor Power of the Pennsylvania Lines west of Pittsburg, has been appointed engineer of tests of the Pennsylvania Railroad at Altoona, Pa.

George Seanor, division foreman of the St. Louis & San Francisco at Joplin, Mo., has been appointed general foreman of shops, with office at Sapulpa, Okla., succeeding J. F. Long, promoted. J. Morgan has been appointed assistant to the general foreman of shops at Sapulpa.

David Hawsworth, for many years superintendent of motive power for the Burlington Lines west of the river, died at Plattsmouth, Nebraska, Friday, August 25, in his 80th year. Mr. Hawksworth was born in England and first began railroad work in the machine shops of the Manchester, Southern and Liverpool Railroad. He came to America in 1849 and after thirteen years alternate service in railroad and steamboat service he enlisted in the United States navy as second assistant engineeer. On being mustered out in 1864 he returned to Burlington, where he remained until 1875 working for the Burlington road. In that year he was appointed master mechanic and was made superintendent of motive power in 1888. He was retired in 1901 at the age of 70 years. He was often called upon for advice after retirement by the managers of the road and his opinions were given much weight. Mr. Hawksworth leaves a widow and five children.

CATALOGS

Grinding Wheels.—The Norton Company, of Worcester, Mass., has just issued a booklet entitled "Safety as Applied to Grinding Wheels," which constitutes a valuable and timely publication in view of the national interest in accident prevention and relief. It illustrates and describes modern safety devices that can be practically applied in the use of grinding wheels and machines.

Electrical Machinery.—In bulletin 3107, 3142 and 3143 the Emerson Electric Mfg. Co., of St. Louis, Mo., illustrates and describes respectively its electric buffing lathes, single phase induction motors, and single phase induction motors back-geared with countershaft. In addition to the complete descriptive matter, the bulletins contain much valuable information for the users of these appliances.

Standard Tool Co.—This company of Cleveland, O., announces the opening of a Western branch at 552 West Washington Boulevard, Chicago, Ill. In this store a complete stock of all styles of twist drills, reamers, milling cutters, taps, drill chucks, taper pins, etc., manufactured by the company will be carried for immediate delivery of orders. The Standard Tool Co. feels sure that the convenience of the new arrangement will be appreciated by the trade in Chicago and the West.

Water Softeners.—The L. M. Booth Company of New York, N. Y., has prepared a booklet describing some standard types of softeners and illustrations of representative installations in active service are also included. The catalog has been confined to the consideration of softeners adapted to the usual requirements, it being thought preferable to reserve for correspondence the discussion of special equipment, which, of course, is of less general interest.

Steel Derricks and Drilling Rigs.—A very complete treatise on the above appliances has been compiled and is now issued in booklet form by the Carnegie Ssteel Company, of Pittsburg, Pa. Three types of derricks are described and illustrated—the Woodworth Standard, the Woodworth Oklama and the Yorke Standard—all of which have their respective advantages. The book contains working drawings and half-tone illustrations and is replete with valuable data on the general subject.

Tank Governors.—The Fulton tank governor, which has been thoroughly tested in railroad service, is described and illustrated in a catalog issued by D. W. Patterson, Harrison Bldg., Philadelphia, Pa. This tank governor is designed to maintain the water level at any desired height with but little variation in tanks, stand pipes, reservoirs, water towers, etc., as to maintain a pressure in water mains at any desired head. It dispenses with the use of float valves or electrical devices for controlling the height of water, but does not prevent their simultaneous use.

Railway Telephones.—The United States Electric Co. of New York, N. Y., sole manufacturers of the Gill selector, has published bulletin No. 502, containing suggested rules for telephone train despatching. These suggested rules have been drawn up in response to requests from the company's patrons for recommendations for this service. They are by no means mandatory, but may be considered as indicative of approved practice, as they embody in the main the requirements appearing in the rules of the principal railway systems using telephone train dispatching.

Ball Bearings.—The Hess-Bright Mfg. Co., of Philadelphia, Pa., has issued leaflets Nos. 68, 69, 70 and 71, in series 336, describing and illustrating respectively the application of floating bushes to grinding machine spindle, method of assembling an adapter with mountings, D. W. F. adapter, and the method of assembling it with bearings on a straight shaft, and ball bearings in horizontal moulding machines. These sheets are in the usual folio size, and prepared for binding. They constitute a valuable addition to past literature on this subject which has been issued by the Hess Bright Company.

Electric Locomotives.—The C. W. Hunt Company of New York, N. Y., was among the pioneers in the development of the electric locomotive for handling trains of industrial railway cars, and when introduced it rapidly

gained favor in those fields where steam and manual power were formerly employed. Its success has been so remarkable that it is now regarded by many purchasers of the industrial railway as a necessary element of the installation. In a recently issued catalog the Hunt Company gives a description of the locomotive, together with illustrations of plants showing it in operation under varying conditions.

GAS-ELECTRIC MOTOR CARS.—The need for self-propelled cars as adjuncts to the regular equipment of steam roads has been apparent for many years, and to-day the General Electric Company, of Schenectady, N. Y., is furnishing such cars capable of fulfilling steam road requirements with economy and reliability. In a recently issued very attractive catalog the company describes and illustrates its gas-electric motor car in detail which leaves nothing to be desired from an informative standpoint. The make-up of the book is artistic to a high degree, and it contains much valuable general information on the subject on which it treats.

PLANERS.—The new catalog issued by the Niles-Bement-Pond Company, of New York, N. Y., illustrates a variety of planers made to conform with the requirements of modern machine tool practice. The description which it includes of reversing motor drive is of special interest. This arrangement is noteworthy on account of its simplicity, and because of the increase in tool efficiency obtained by its use. By decreasing the number of moving parts the maintenance charges are materially reduced, and the increase in the number of variations of cutting and return speeds available makes any given size of machine suitable for a very wide class of work. This type of drive is now applied to any size or type of reversing planer.

PULSOMETER STEAM PUMPS.—The Pulsometer Steam Pump Co., of New York, N. Y., has just issued a new catalog which in reality constitutes a complete treatise on this pioneer of the vacuum type of steam pump. The descriptive matter is thorough and is enhanced by very clear sectional drawings and half tones which render easily understood the construction and operation of the device. The catalog contains a number of illustrations from actual practice showing every application of the pulsometer to construction, quarry and bridge work from which it may be gathered that it constitutes an ideal machine for contractor's use. The latter portion of the catalog contains tables and information of value to steam pump users.

ELECTRIC MOTORS.—Bulletin No. 4869, just issued by the General Electric Company, is an attractive publication devoted to motor drive for the printing and allied trades. The advantages to be derived from motor drive in this industry are the improved plant location made possible by the use of central station power, reliability, speed variation and control, economy of space, increased production, economy of power, and, what is exceedingly important in the printing trade, cleanliness. The publication illustrates motors and the necessary controllers, for both direct and alternating current circuits, and applicable to job and cylinder presses of all sizes and kinds, and to stitching, perforating, cutting, numbering, folding and punching machines.

ANOTHER BETTENDORF BEAR BOOK.—The children of the railway fraternity will be overjoyed to know that the Bettendorf Axle Company has issued another story of the Bettendorf bears by Bruce V. Crandall, entitled "Goldenhair and the Bettendorf Bears." It tells in rhyme of the wonderful experiences of a general manager's little daughter who was conducted over the Bettendorf plant in Animal Town by her friends the bears. Here she was shown many wonderful things and became fascinated with the inhabitants of Animal Town and the work they did in their factory. The illustrations are particularly well executed and well suited to the little folk to whom the book is dedicated.

ELECTRICAL MACHINERY.—The General Electric Co., of Schenectady, N. Y., has issued Bulletins Nos. 4819, 4825, 4826, 4827 and 4831, descriptive respectively of alternating current switchboard panels; General Electric switchboard instruments; water meters, air flow meters, and oil break switches for manhole service. As usual in the instance of the General Electric Co.'s bulletins, the various subjects are fully discussed and appropriately illustrated. In particular Bulletin No. 4819 on alternating current switchboard panels is of exceptional value, as it clearly defines and explains many terms and points, a knowledge of which is not widely diffused outside of the electrical engineer's profession.

WALSCHAERT VALVE GEAR.—Record No. 70, issued by the Baldwin Locomotive Works, Philadelphia, Pa., is devoted to a thorough description of this gear, supplemented by a number of finely executed half tones and line drawings. The feature of particular value in connection with the record is a detailed method of setting valves with the Walschaert gear, both for outside and inside admission, and which is one of the most comprheensive and lucid analysis of the operation that has yet appeared in print. Hypothetical cases are introduced which graphically portray irregularities and the method of their correction. Since the year 1905 the Walschaert valve gear has come to be more generally employed than any other form of motion, and this fact endows the record with a particular value at this time.

BALL BEARING HANGERS.—Under this title the Hess-Bright Mfg. Co. of Philadelphia, Pa., has issued a very attractive and instructive catalog dealing with the construction and application of these devices. In the purchase of the equipment of a new factory, or in the remodeling of an existing plant, often very little consideration is given to the selection of the hangers to hold and support the line and counter-shafting. To many shop owners a hanger is simply a "hanger," no thought being given to the saving that can be effected through the elimination of friction and the consequent increased efficiency of the power plant. The pages of this catalog contain information that will prove of interest to every power user, and the valuable data which it embodies renders it an important addition to the existing literature on the subject.

REFLEX WATER GAGES.—The Jerguson Gage & Valve Company, of Boston, Mass., has recently issued a booklet descriptive of reflex water gages (Klinger type) which are adapted for use on marine, locomotive and stationary boilers, separators, tanks, etc. The reflex gage involves a simple and fundamental principle of the law of optics, namely, the total reflection of light when passing from a body of greater refractive into one of less refractive power. This gage insures quick and accurate reading of the water level, as the water always appears black, and white indicates immediately the absence of water. The catalog is handsomely illustrated in color and includes also a description of the various types of water glass fittings manufactured by the Jerguson Company.

RINGS, SHELLS AND RING DIES.—The Standard Steel Works Co., Philadelphia, Pa., have just issued a new catalog on rings, shells and ring dies. This very interesting publication contains illustrations of the various types of this class of material, such as are used in the Chilean, Huntingdon, Griffin or Bradley, Kent, and Bryan Mills, as well as cuts of rolled steel rings which are used for various other purposes. The catalog also contains cuts showing gear rims and blanks for built-up gears for heavy electric service, built-up wheels for Bascule bridges, and wheels for mining service. On the last few pages it contains tables of dimensions of peened, screw, welding and plain pipe flanges as well as fac-simile of dimension blanks used is the ordering of wheels.

THE JACOB SCHUPERT SECTIONAL FIREBOX.—A most attractive and interesting treatise, confined to a description of the features of the Jacob Schupert firebox, is being issued by the Jacob Schupert U. S. Firebox Company, 30 Church St., New York. It is a book of 100 pages, printed on heavy calendered paper and illustrated with most excellent reproductions from photographs and deals in detail with the construction and advantages of this type of firebox in correcting the known disadvantages of the present arrangement. The unfavorable features of the present locomotive firebox are clearly recognized by all, and it is believed by the manufacturers that this design, with which our readers are fully acquainted, corrects practically all the troubles now experienced. This book, bound in cloth, is very complete in all its features and will be found very valuable by all interested in locomotive boilers.

NOTES

STANDARD TOOL CO.—This company, of Cleveland, O., has appointed L. Hussey to the position of advertising manager.

BALDWIN LOCOMOTIVE WORKS.—It is announced that the Portland, Oregon, office of the above company has been moved from 809 Couch Building to 722 Spalding Building.

ASHTON VALVE CO.—J. W. Motherell, assistant to the vice-president of the Ashton Valve Co., Boston, Mass., has been appointed vice-president and manager of the railway department.

S. SEVERANCE MFG. CO.—S. Severance, who has been President and Manager of the S. Severance Manufacturing Company since its formation, severed his connection with that company on September 1st.

PRENTISS TOOL & SUPPLY CO.—Announcement is made by this company, of New York, N. Y., of the removal of its office and salesroom from 115 Liberty Street to the Singer Building, 149 Broadway, New York.

DEARBORN DRUG AND CHEMICAL WORKS.—Thomas H. Platt, who is well known to the engineers of New York, is now associated with the above company and will make his headquarters at the Eastern office, 299 Broadway, New York. Mr. Platt's territory will comprise Greater New York.

HOMESTEAD VALVE MFG. CO.—Announcement is made by this company, of Pittsburg, Pa., of the appointment as agents in Scranton and vicinity of Charles P. Scott & Company of 119 Franklin avenue, that city, who will be ready to supply the trade at all times.

BEST MANUFACTURING CO.—Benjamin T. Delafield, who formerly represented the Lunkenheimer Company for a number of years in the St. Louis and Kansas City territory, has become connected with the Best Manufacturing Company of Pittsburgh, Pa., to handle their line of valves, fittings, flanges, pipe bends, fabricated pipe and other power plant material in the same territory. He will make his headquarters in Kansas City.

AMERICAN LOCOMOTIVE CO.—The tenth annual report of this company for the fiscal year ending June 30th shows that the gross earnings for the year, $40,649,385, were $8,445,993 greater than the preceding year and over twice as large as the year 1908-9. The surplus, after a charge for depreciation on all classes of property of $1,056,417 and the payment of the preferred dividend, was $1,815,561, as compared with $334,758 in the preceding year.

The Speed and Acceleration Problem

By G. E.

HAVING THE CHARACTERISTIC CURVES OF AN EXISTING OR PROPOSED LOCOMOTIVE, A METHOD OF ACCURATELY DETERMINING THE SPEED AND TIME WHICH IT WILL GIVE WITH ANY ASSUMED TRAIN FOR ANY PARTICULAR SECTION OF AN EXISTING OR PROPOSED ROAD, IS DEMONSTRATED IN THIS ARTICLE.

The necessity occasionally arises for estimating the time in which a proposed motive power not yet built, or to be altered, can pass over an existing road or a proposed line. This would be very simple if the tractive effort of the locomotive or motor car and the resistance of the train were constant at all speeds, and the methods which appear to have heretofore been used for this kind of work are based on the assumption of a constant difference between the tractive force and the resistance through the whole range, or through part of the range, of speed variation.

Actually this difference, or unbalanced tractive effort, decreases as the speed increases, and becomes zero if the train reaches the "balancing speed," or the velocity at which the tractive effort just equals the resistance. If, now, the length of track under a given condition of grade is sufficient to enable the train practically to reach the balancing speed, a superficial view would suggest that correct results could be obtained by taking half the initial unbalanced tractive effort as the average accelerating force, and substituting it in the well-known formulas:

$$f = m\,a = \frac{w\,a}{g} \quad \ldots\ldots\ldots \quad (1)$$

$$a = \frac{f}{m} = \frac{f\,g}{w} \quad \ldots\ldots\ldots\ldots \quad (2)$$

$$v = a\,t = \frac{f\,g\,t}{w} \quad \ldots\ldots\ldots \quad (3)$$

$$s = \frac{a\,t^2}{2} = \frac{f\,g\,t^2}{2\,w} \quad \ldots\ldots\ldots \quad (4)$$

in which f = the accelerating force.
m = the mass of the train.
a = the acceleration in feet per second per second.
w = the weight of the train in pounds.
g = the acceleration due to gravity = 32.16 ft. per second per second.
v = the velocity in feet per second.
t = the time in seconds.
s = the distance in feet.

But, since the unbalanced tractive effort at the start is much larger than assumed, the speed increases very rapidly at first and very slowly when the balancing speed is approached, with the result that the average speed is much greater than it would be under the conditions substituted for the real ones. Consequently, the distance traveled will not be even approximately correct. A closer approximation can be made by successive calculations for short intervals of time. For example, if intervals of five seconds are chosen, the velocity and distance during the first interval from the start are calculated from equations (3) and (4) respectively. Then the unbalanced tractive effort at the velocity just found, is used for f in equation (3) to find a new velocity to be added to that acquired in the first interval. The distance traveled in the second interval is

$$s' = v'\,t + \frac{f\,g\,t^2}{2\,w}$$

in which v' is the speed at the beginning of the interval, in feet per second. The process is then carried out for a third interval, and so on. There are various modifications of these methods, some so erroneous as to be useless, and others in which a degree of approximation is reached through a method too laborious for an extensive study, but the preceding are believed to be typical.

A simple and novel method has recently been devised for this kind of work, which the writer hopes will be of interest. While

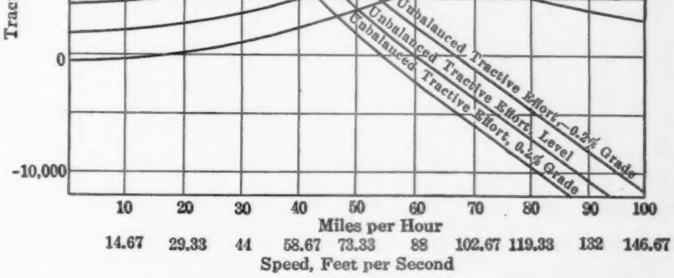


FIG. I.

some will brand it as "theoretical," and would prefer to build the motive power and the road first and to tell afterward what time can be made, the business man wants to know what the results will be before expenditure is made. When, therefore, orders are received that such an estimate is to be submitted, there is a very practical phase to any method that enables it to be made with a good degree of accuracy and at a reasonable cost. While the data should be determined with the utmost care, the actual work is little else than planimetry and plotting.

First the tractive effort and the train resistance are plotted as shown in Fig. 1. Much has been printed in the technical papers, in books, and in the proceedings of the engineering societies on tractive effort and train resistance, and the engineer should satisfy himself through such sources and his own experience as to the correctness of these curves, for the reliability of the whole work depends upon them. It may be necessary to plot

resistances for other grades as well as those shown. The curve of accelerating force, or unbalanced tractive effort, is, of course, plotted by taking differences between the total tractive effort and the resistance; for example, at 50 miles per hour the tractive effort is 10,600 lbs., the resistance on the 0.2 per cent. grade is 8,900 lbs., and the unbalanced tractive effort is 1,700 lbs. For

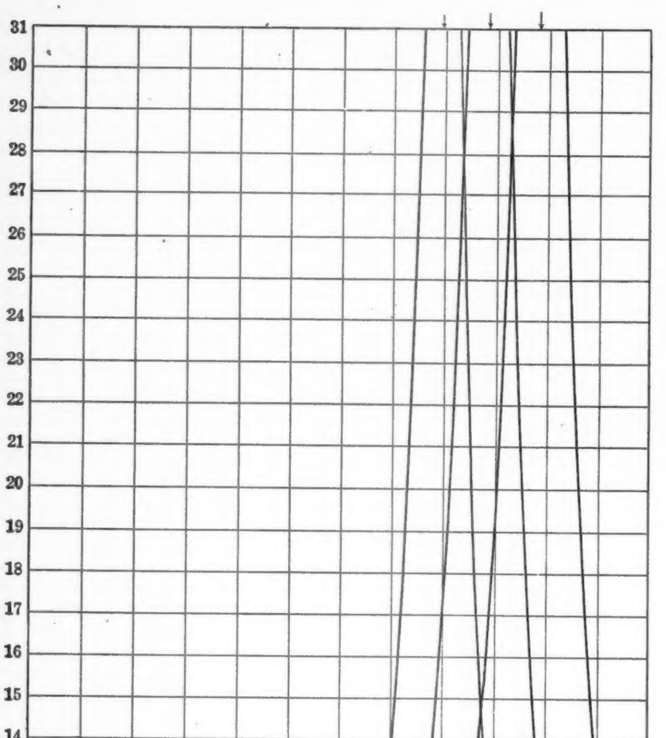


FIG. 2.

any grade the tractive effort and resistance curves cross at the balancing speed, and the curve of unbalanced tractive effort crosses the zero line at the same speed.

In Fig. 2 are plotted values of $\frac{1}{a}$ or $\frac{w}{g f}$ (see equation 1), the value of f being taken from Fig. 1 for each speed plotted. Since the accelerating force is not absorbed in the linear acceleration alone, but must alter the angular velocity of the wheels and axles, an allowance for this extra effort must be made. This can be done by adding to the weight of the train the values of $\frac{g I}{r^2}$ for all the rotating parts, which may be expressed as $\Sigma \frac{g I}{r^2}$, I being the moment of inertia and r the radius of the tread of the wheel. I is, of course, equal to $\Sigma \frac{w q^2}{g}$, where w is the weight of an elementary particle of the wheel and q its distance from the center. The allowance for the rotating parts may be expected to lie between 2 per cent. and 8 per cent. of the total weight.

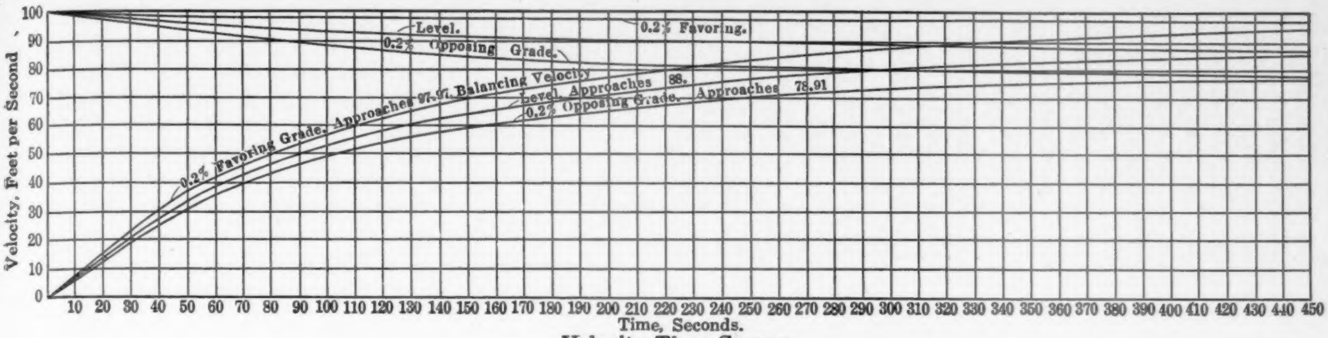
Under favorable circumstances a train may reach a given grade at a speed higher than the balancing speed. It will then be retarded, and the acceleration as well as its reciprocal will have negative values. The curves at the right-hand side of Fig. 2 should strictly, therefore, be inverted and placed below the zero line, so that the complete curve for any grade passes from the positive to the negative values through the infinite value at the balancing speed. The curves are all plotted above the zero line, however, on account of the convenience of the small diagram.

Now let dv represent the small increase in velocity from E to B (Fig. 2), and let dA represent the area of the small strip $B\ C\ D\ E$.

$$dA = \frac{w}{f g} dv \text{ (nearly).}$$

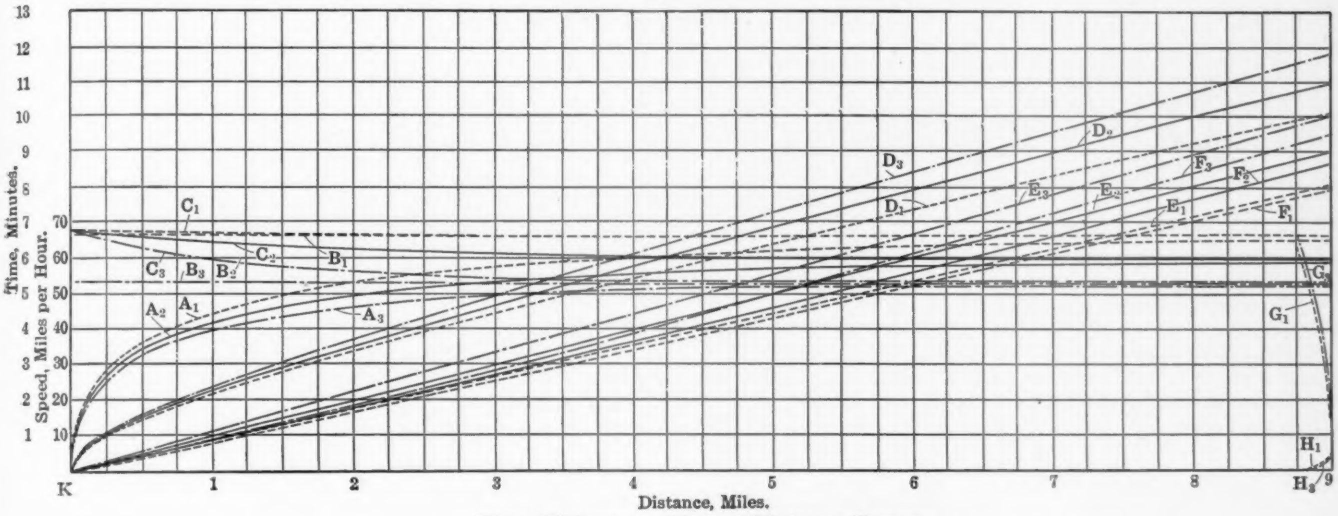
But (equation 2) $a = \frac{f g}{w}$ and a, being the rate of change of speed with reference to the time, is equal to $\frac{dv}{dt}$, in which dt is the short interval of time in which the speed increases from E to B. Then $dA = \frac{1}{a} dv = dt$. That is, the area $B\ C\ D\ E$ is equal to the time required for the velocity to increase from E to B, and the whole area $B\ C\ G\ F$ must equal the time required to reach the speed indicated at B from the start. This principle is applied in plotting the velocity-time curves of Fig. 3. For example, the time to plot horizontally at the height of the speed of 30 feet per second is equal to the area under the acceleration-reciprocal curve of Fig. 2 between the zero and 30 ordinates and that for the speed of 50 feet per second is similarly obtained from the area between the zero and 50 ordinates. The planimeter should, of course, be adjusted to the scales and units of measurement adopted, or the results should be multiplied by the proper factor. For the retarded velocity, in this case plotted from that of 100 feet per second, areas are measured to the left from the 100 feet per second ordinate. The problem of the momentum grade is an extreme case of retarded velocity. These speed curves should approach indefinitely the balancing speed indicated in Fig. 1.

Since the distance traveled in a short interval, dt, is equal to $v dt$, it follows that the total distance traveled in a given time is equal to the area under the velocity-time curve of Fig. 3. By measuring these areas, therefore, distances are found at which both the time and the speed can be plotted as in Fig. 4. The speed-distance curves should approach the balancing speed indefinitely, and the time-distance curves should approach indefinitely the condition of being straight lines parallel to the inclined straight lines representing the time-distance relation if the train had been traveling all the time at its balancing speed. The vertical distance between these lines represents the time lost in accelerating. For example, if the train passes a given point on a 0.2 per cent. grade at its balancing speed, about 54 miles per hour, it will reach a point seven miles beyond in 7.8 minutes. But if it is started from a stand-still it would require



Velocity-Time Curves.

FIG. 3.



Time-Distance and Speed-Distance Curves.

Subscript "1" and dotted lines indicate 0.2 per cent. favoring grades.
Subscript "2" and full lines indicate level track.
Subscript "3" and broken lines indicate 0.2 per cent. opposing grade.
Curves *A* show speeds from start.
Lines *B* show balancing speeds.
Curves *C* show speeds from 100 ft. per sec., or 68 miles per hour.
Curves *D* show distances from start.
Lines *E* show distances at balancing speed.
Curves *F* show distances from a speed of 100 ft. per second or 68 miles per hour.
Curves *G* show speeds with brake applied.
Curves *H* show distances with brake applied.

FIG. 4.

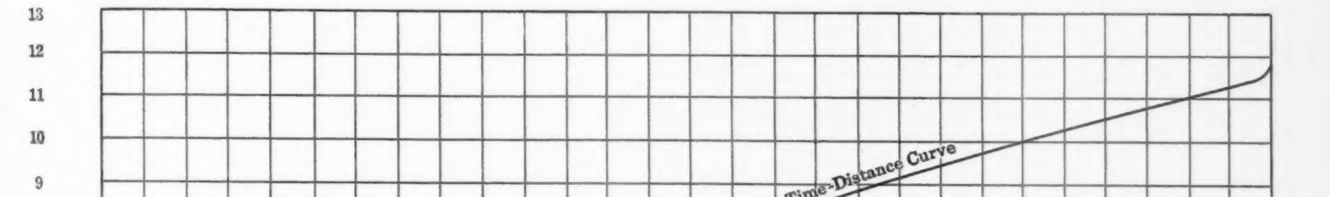


FIG. 5.

about 9.6 minutes to travel those seven miles, and 1.8 minute would have been lost.

The speed and distance curves for the brake can be found in the same way, but the deceleration for the brake is so much nearer constant, and the time when the brake is applied is so short, that the formulas (3) and (4) can be used without serious error.

The final result is to be exhibited in such a diagram as Fig. 5, in which the same scales for time, speed and distance are adopted as in Fig. 4. The grades are compensated, and the profile laid off on tracing cloth. It is assumed that the speed during the latter half of the third mile is to be limited to 15 miles per hour on account of operating conditions. The track starts with a 0.16 per cent. grade. The tracing cloth being placed on Fig. 4 so that *H* and *K* coincide, the time curve *H I* and the speed curve *H J* are drawn, interpolating between the curves

for level track and for 0.2 per cent. in Fig. 4. The cloth is then moved horizontally until J falls on the speed curve for level track, and $J\ L$ is traced. Then the cloth is moved vertically until I falls on the distance curve for level track, and $I\ M$ is drawn. $N\ O$ is drawn at 15 miles per hour, and N is placed so that it falls on the brake curve. $L\ N$ is then drawn to meet the previously drawn speed curve, and the cloth moved vertically until M falls on the distance curve for the brake, when $M\ P$ is drawn. The remainder is traced in a similar way.

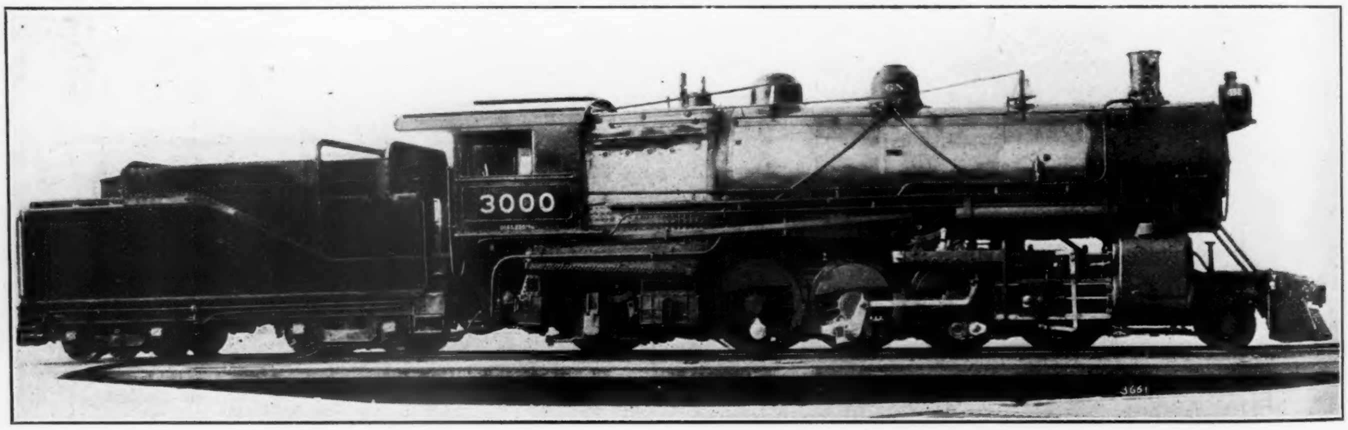
Although the explanation of the method is somewhat tedious, the actual work is much simpler than accurate calculations. The use of curves makes it unnecessary to plot so many points as would have to be calculated, and the relations of the curves are so apparent that an error would be quickly discovered. Moreover, the diagram of Fig. 4 having once been made, can be applied to any number of miles of the final Fig. 5 diagram.

Superheater Locomotives 2-8-2 Type

GREAT NORTHERN RAILWAY.

TWENTY LOCOMOTIVES RECENTLY DELIVERED BY THE BALDWIN LOCOMOTIVE WORKS, WHICH HAVE BEEN PUT IN SERVICE ON THE GREAT NORTHERN RAILWAY, ARE AMONG THE MOST POWERFUL OF THE SIMPLE LOCOMOTIVES ON OUR RECORD, BEING PRACTICALLY EQUIVALENT TO THE MALLETS WHICH THAT COMPANY HAS IN ROAD SERVICE.

As our readers are well aware, the past year has shown a great revival of interest and a very general development of the 2-8-2 or Mikado type locomotives for freight service. This design has been continually enlarged and improved, greatly surpassing anything which was considered possible when it was practically abandoned four or five years ago until it now occupies a position which, until a comparatively recent period, it was believed could be covered only by the Mallet type. The reason for this renewed lease of life will be found principally in the success of the high degree superheater which has so greatly increased boiler capacity as to permit a boiler of sufficient capacity per unit of weight to be mounted on four coupled drivers without exceeding a safe axle load, and enable the locomotive to deliver a very high ratio of its maximum tractive effort at moderately high speeds. In the September issue, on page 346, will be found a discussion of the comparative merits of the consolidation and the Mikado type locomotive, wherein it is pointed out that while the maximum theoretical tractive effort of the Mikado could be attained by the consolidated type, it is the sustained high tractive effort at high speed, which means boiler capacity, that is assured by the former.

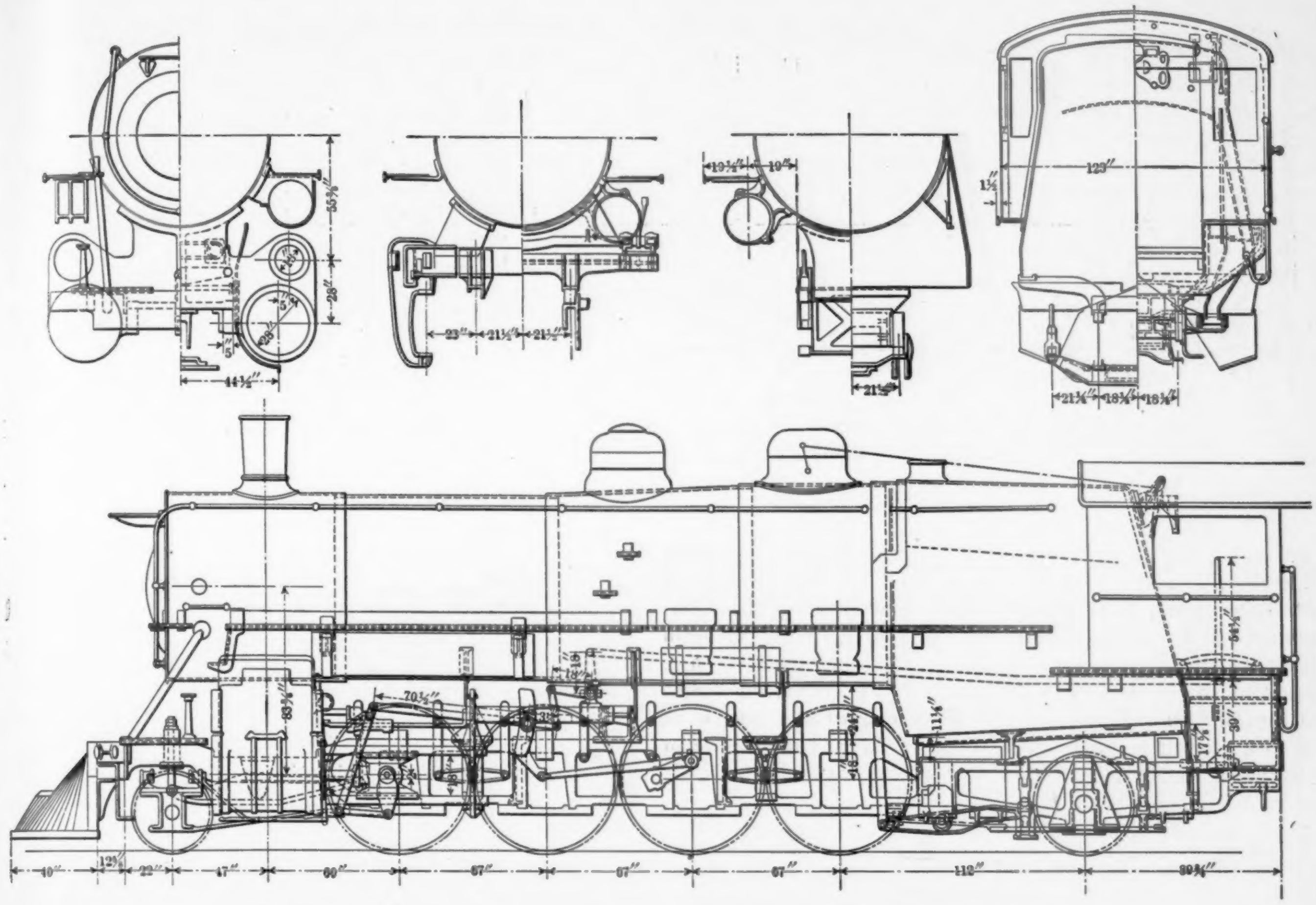


VERY POWERFUL LOCOMOTIVE EQUIPPED WITH EMERSON SUPERHEATER.

On the locomotives illustrated herewith, a boiler 82 in. in diameter at the front ring and 89 in. maximum diameter, having 21 ft. flues, and a grate area of 78.2 sq. ft., has been applied. It is fitted with an Emerson high degree superheater having 1,060 sq. ft. of heating surface and the pressure has been reduced to 170 lbs. This boiler is of practically equivalent size, but is of greater capacity than the one applied to the 2-6-6-2 type locomotives, of which there are 45 in service on this road. These locomotives were illustrated and described on page 213 of the June, 1907, issue of this journal. They were not fitted with superheaters, although a later order of the 2-6-8-0 type, considerably larger in size, were equipped with Emerson superheaters and also feed water heaters.

In accordance with the Great Northern Railway Company's practice, the boiler is of the Belpaire type and has both the crown sheet and outside roof sheets slightly arched. The water spaces at the mud ring are 5 in. in width, increasing to 6½ in. at the sides and 8¼ in. in the back water leg. In one of the illustrations will be seen the arrangement and location of the 5½ in. tubes enclosing the superheater elements, there being thirty of them. It will be remembered that the Emerson superheater employs headers somewhat similar in shape and location to the ordinary steam pipes. An improvement has been made in this application, in that the saturated and superheated steam chambers are in separate castings, which are bolted together, leaving an air space between. The bolt holes are sufficiently large to permit of movement due to the different ratios of expansion of the two sections. These headers connect to the steam passages in the saddle in the usual manner, but a 5½ in. pipe connects the two passages below the header connection, thus permitting the equalization of pressure and allowing each cylinder to draw on both superheater sections for its supply. The cylinders are 28 in. x 32 in., the walls being made thick enough to permit boring to 29 in. in diameter if desired. These cylinders are somewhat larger than the ones applied to the Illinois Central Mikado type, illustrated in the September issue, but in other respects the two designs are very similar. The Illinois Central engine having the Schmidt superheater of practically the same size is the Emerson applied here.

A novelty is found in this design in connection with the ash

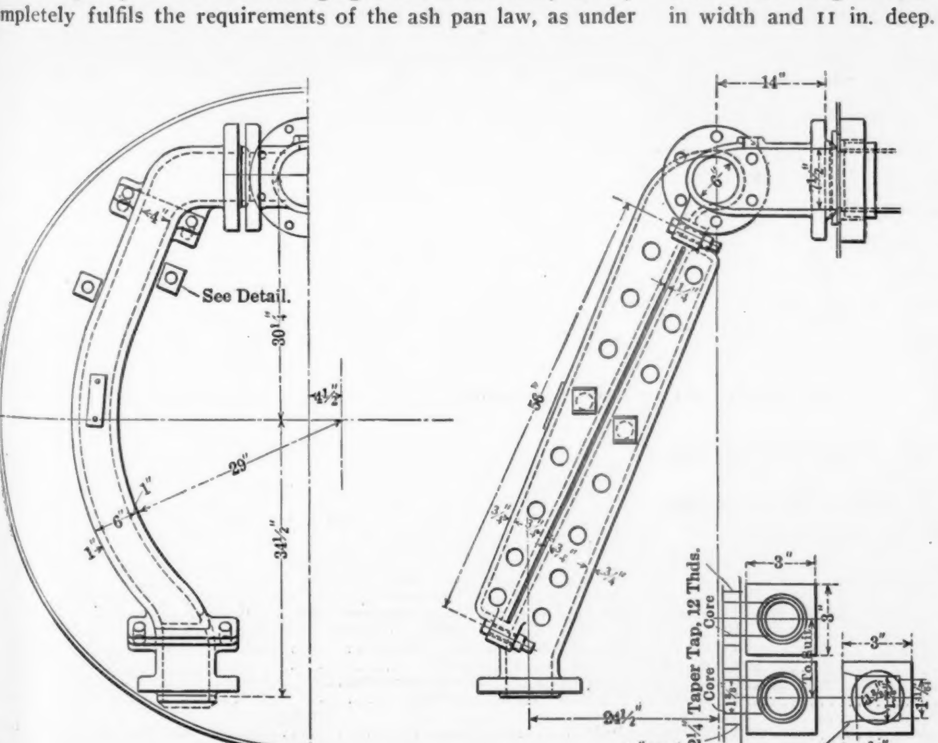


ELEVATION AND SECTIONS OF MIKADO TYPE LOCOMOTIVE ON THE GREAT NORTHERN RY.

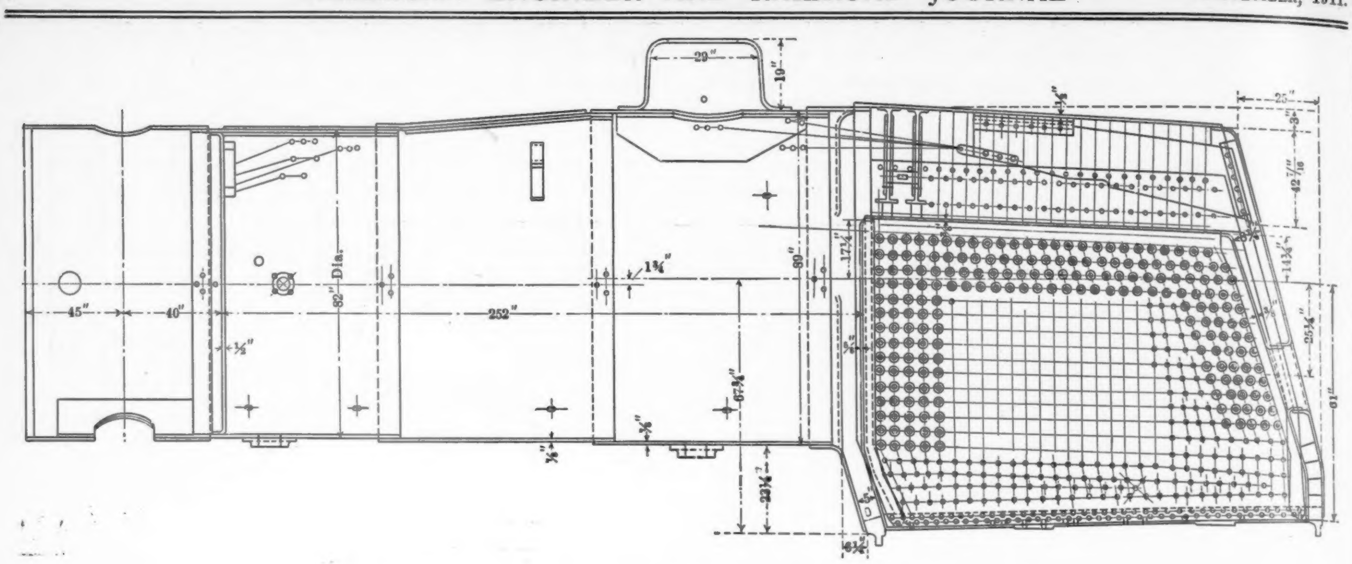
pan, which has six hoppers, all arranged to discharge outside the rail. The lower section of each of the hoppers is formed of cast iron plates and provided with a hinged door, the two forward ones being operated together from one gear, all operation being by hand. Details of this construction are clearly shown in the illustration. While this ash pan probably does not have any greater capacity than one discharging between the rails, it very completely fulfils the requirements of the ash pan law, as under no conceivable circumstances would a man have to get underneath the engine in cleaning it. It will be noted, however, that cinder pits having one rail on the outer wall of the pit would not be suitable for use with this pan.

In other particulars there is little of novelty in connection with the details of the design. It will be noted that the front frames are integral with the main frames, the slab being 5 in. in width and 11 in. deep. The driving boxes are of cast steel faced with babbitt, the wheels have no hub liners. The side rods are rectangular in section and castle nuts are used throughout all the motion work. It will be noted that the throttle rigging is outside of the boiler, the lever being in a vertical position on the back head and connecting to an arm on the horizontal shaft projecting out through a stuffing box in the side of the dome.

The tender is designed in accordance with the Great Northern standards and has equalized pedestal trucks and 12 in. steel channel frame placed unusually low. This lower center of gravity has been obtained principally by a special design cast steel truck bolster. In the coal space, a coal pusher arrangement has been provided, the general features of which are shown in one of the illustrations. This consists of a hopper of a shape and size to closely fit the space in the tender from the bottom of the slope sheet backward, being hinged at the forward bottom end, but not otherwise connected to the

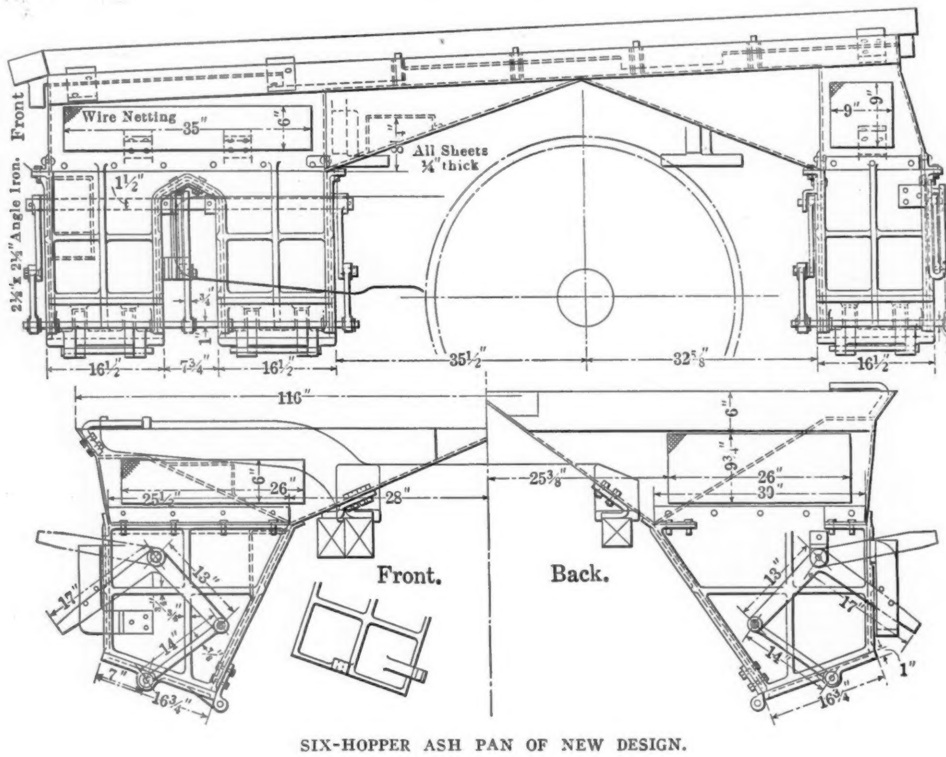


DETAIL OF EMERSON SUPERHEATER HEADER.



BELPAIR BOILER ON GREAT NORTHERN 2-8-2 TYPE LOCOMOTIVES.

tender. Near the back end of this hopper and on the center line there is a cast iron cylinder, extending vertically through the water space, in which there is a trunk piston with a connecting rod secured underneath the coal hopper. A 1¼ in. steam pipe connects to the bottom of this cylinder, and when steam is admitted, the whole hopper is lifted, swinging around the hinges at the forward end, and the coal slides forward, the amount of the lift, of course, depending upon the length of time the steam pressure is supplied. In this manner, all the coal in the space is



SIX-HOPPER ASH PAN OF NEW DESIGN.

brought to a convenient location for the fireman without extra labor on his part.

The general dimensions, weights and ratios of these locomotives are given in the following table:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	57,500 lbs.
Weight in working order, estimated	287,000 lbs.
Weight on drivers, estimated	220,000 lbs.
Weight on leading truck, estimated	27,000 lbs.
Weight on trailing truck, estimated	40,000 lbs.
Weight of engine and tender in working order	435,000 lbs.
Wheel base, driving	16 ft. 9 in.
Wheel base, total	35 ft.
Wheel base, engine and tender	68 ft. 2 in.

RATIOS.

Weight on drivers ÷ tractive effort	3.83
Total weight ÷ tractive effort	4.98
Tractive effort × diam. drivers ÷ heating surface*	572.00
Total heating surface* ÷ grate area	81.00
Weight on drivers ÷ total heating surface*	34.70
Total weight ÷ total heating surface*	45.40
Volume both cylinders, cu. ft	22.80
Total heating surface* ÷ vol. cylinders	278.00
Grate area ÷ vol. cylinders	3.44

CYLINDERS.

Kind	Simple
Diameter and stroke	28 x 32 in.

VALVES.

Kind	Piston
Diameter	13 in.
Greatest travel	6 in.
Outside lap	1⅛ in.
Inside clearance	0 in.
Lead	3-16 in.

WHEELS

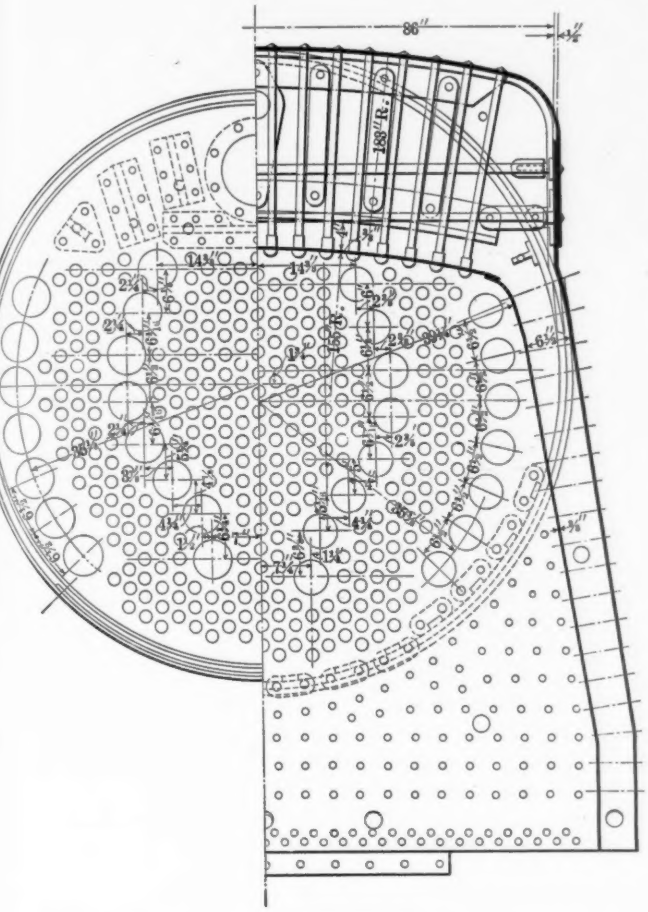
Driving, diameter over tires	63 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	11 x 12 in.
Driving journals, others, diameter and length	10 x 12 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	6 x 12 in.
Trailing truck wheels, diameter	42½ in.
Trailing truck, journals	8 x 14 in.

BOILER.

Style	Belpair
Working pressure	170 lbs.

* Equivalent heating surface = 6,310 sq. ft.

Outside diameter of first ring	82 in.
Firebox, length and width	117 x 96 in.
Firebox plate, thickness	⅜ x ⅝ in.
Firebox, water space	5 in.
Tubes, number and outside diameter	30—5½ in.; 326—2 in.
Tubes, length	21 ft.
Heating surface, tubes	4,471 sq. ft.
Heating surface, firebox	249 sq. ft.
Heating surface, total	4,720 sq. ft.



SECTION OF BOILER SHOWING ARRANGEMENT OF SUPERHEATER TUBES.

Superheater heating surface	1,060 sq. ft.
Grate area	78.2 sq. ft.
Center of boiler above rail	117 in.

TENDER.

Tank	Fitted with coal pusher
Frame	Steel
Wheels, diameter	36 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	8,000 gals.
Coal capacity	13 tons

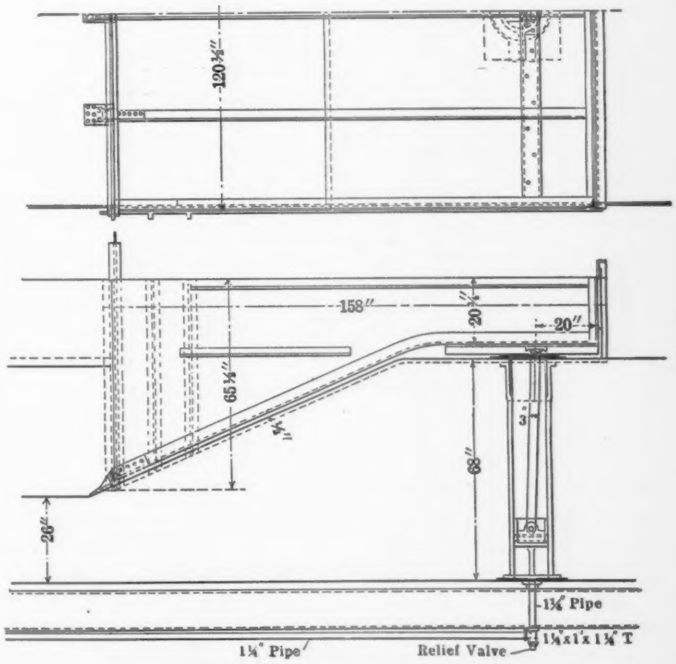
ELECTRIC LOCOMOTIVES FOR PANAMA CANAL

These unique engines for which it is understood bids have been asked for will in many respects become the greatest novelty on the waterway. Four of them will be required to tow a vessel of moderate size, two ahead (one on either wall) and two trailing behind to keep the vessel in the middle of the lock and bring it to a stop when entirely within the lock chamber. Each locomotive will consist of a body and two trucks, the body containing a motor-driven windlass for hauling in or paying out the tow line under load and a high-speed motor-driven attachment for coiling the line when it is out of service. The windlass drum will be fitted with a friction device to prevent the load on the tow line exceeding 25,000 lbs. This body will be supported by a partly flexible connection at each end on a truck. The two trucks will be identical, each containing traction motors and control apparatus.

When towing or taking the inclines between the locks, which are quite steep, the locomotive will operate as a rack-rail tractor, being propelled by the traction motors driving the rack pinions through gearing. These rack pinions will be of the quill-construction type and mounted on the back axle of the truck, allowing the truck wheels to run free. The towing speed will be 2 miles per hour. In returning, except on the inclines between the lock levels, the locomotive will travel under friction tractive effort at about 5 miles an hour, this change of speed being provided for by throwing in jaw clutches connecting the wheels of the trucks with the traction motors. The motors are required to have brakes able to stop them in 15 revolutions when running at full speed. The trucks will travel on a 5-ft. gauge track; the inclines between lock levels have a grade of 1 on 2, with vertical curves of 100 ft. radius, and the horizontal curves are of 200 ft. radius.

The motors for traction purposes are required to have a full-speed torque of 840 lbs. at 1-ft. radius and a full-load speed of not less than 470 r.p.m., and must be capable of developing at least 75 per cent. greater torque for a period of 1 minute. The motor for the windlass must have a full-speed torque of 120 lbs. at 1-ft. radius and a full-speed load of 660 r.p.m., and be capable of exerting 50 per cent. greater torque for 1 minute. The motor for coiling the cable is much smaller. All of them are to be three-phase, 25-cycle, induction motors of the railway or mill type. Current will be taken from a conduit containing two conductors, the third phase being carried by the two track rails.

THE AMERICAN RAILWAY ASSOCIATION.—The fall session will be held at the Blackstone Hotel, Chicago, Ill., on Wednesday, November 15, at 11 A. M. Reports will be presented by the following committees: Executive Committee; Committee on Transportation; Committee on Maintenance; Committee on Relations between Railroads; Committee on the Safe Transportation of Explosives and Other Dangerous Articles; Committee on Electrical Working, and Committee on Nominations. Three members of the Committee on the Safe Transportation of Explosives and Other Dangerous Articles, two members of the Committee on Electrical Working and two members of the Committee on Nominations are to be elected at this meeting.



COAL PUSHER ON TENDER OF MIKADOS—G. N. RY.

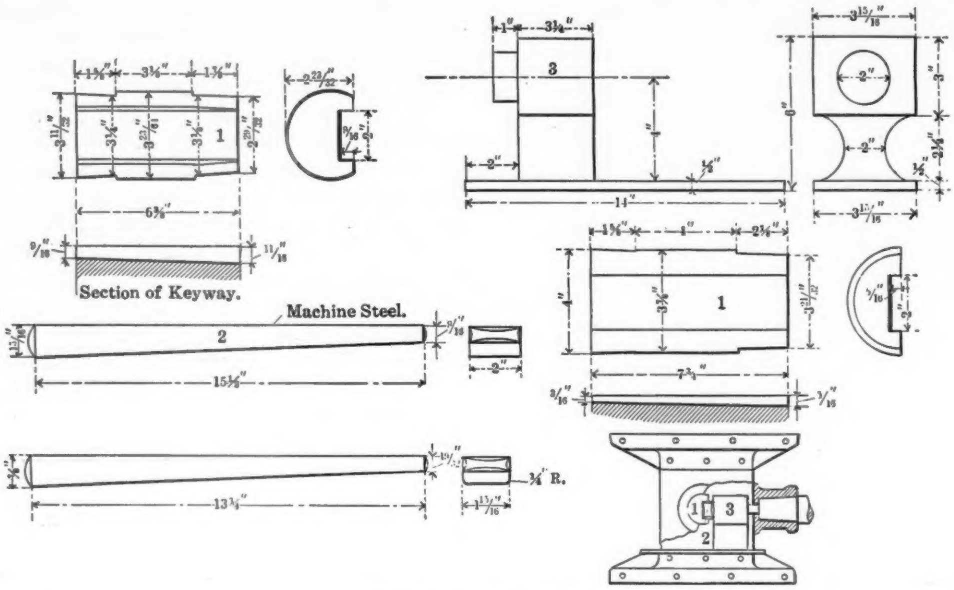
IN ORDER THAT THE ENTIRE Baltimore and Ohio system may benefit by the tests and experiments made on fuel coal a fuel bureau has been organized in the office of the general manager to conduct experiments based on the performance of all classes of locomotives in both passenger and freight service.

SOME NEW JIGS AND METHODS

CHICAGO & NORTHWESTERN RY.

Supplementing the shop devices used on the above road, which **were described** and illustrated in the preceding issue of this **journal,** those commented on below may be found of interest. **It will** be noted that they are of simple design, quite inexpensive and their construction indicates thorough efficiency for the various purposes intended.

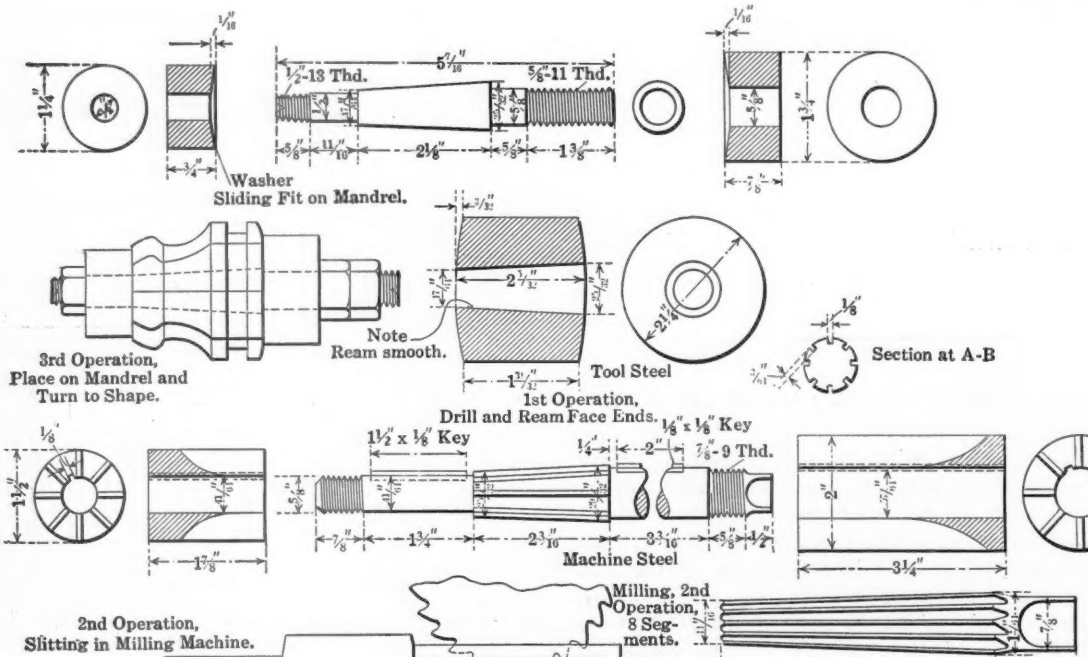
Great ingenuity is being displayed at the present time throughout the country generally in devices for the removal of piston rods from crossheads, and accordingly the one herein illustrated will repay examination as it is particularly applicable to alligator crossheads which are the prevailing type at present. The construction embodies an old wrist pin, planed on one side as shown in No. 1, and having a lengthwise keyway to receive the tapered key No. 2. A steel forging No. 3 rests on the top side of the bottom gib, and is so blocked up that the round boss on the end comes central with the piston rod in the crosshead.



PISTON ROD REMOVER.

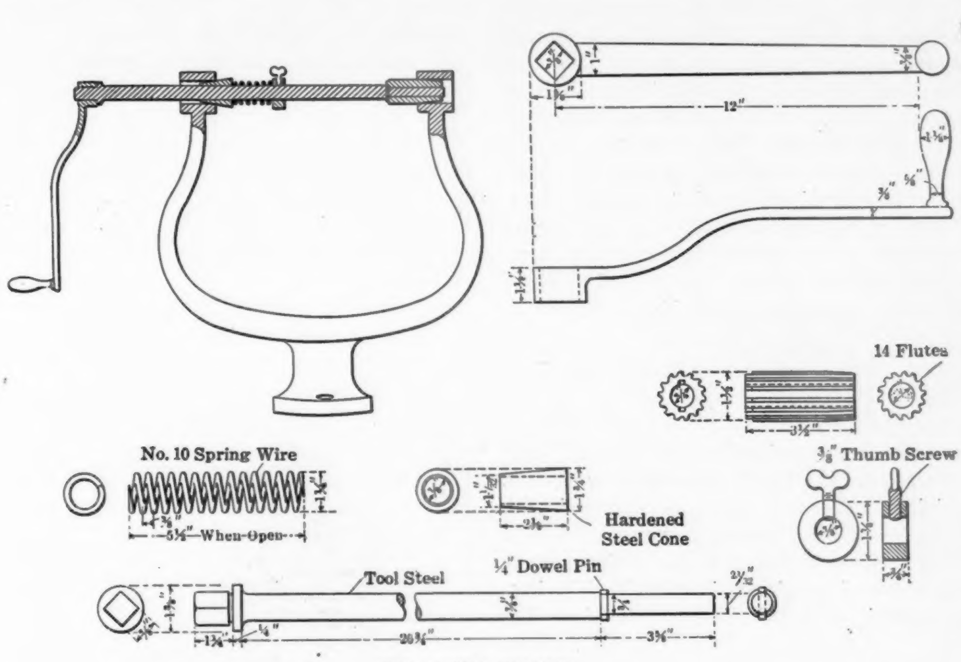
To disconnect the latter parts the forging should first be placed as above indicated; the special wrist pin No. 1 applied and afterwards the key, when lightly tapped, will readily back out the rod without damage to it or the crosshead. In this connection it may be added that any device which will prevent burring or scarring these parts is worthy of a trial as they are accorded some rather rough handling on not a few roads where the piston pulling facilities are inadequate.

The jigs and tools for making flue expanders were designed by machinist Jensen, of the Clinton, Iowa, shop and are said to do very cheap and accurate work. The first operation is to drill and taper ream a piece of annealed tool steel of the required diameter and length. This reamer as shown is to ream the tapered hole. This piece of steel is slightly rounded on both



JIGS FOR MAKING FLUE EXPANDERS.

ends which fits the concave washers on the mandrels to hold the pieces together while being slit in the machine, as shown in the second operation. After the piece of steel is slit in eight equal pieces they are placed on the mandrel, as the third operation indicates, and turned up to a gauge which duplicates the section. The drawing is quite complete in detail and should give full information to those desiring to make flue expanders this way, without further explanation.



BELL YOKE REAMER.

As practically all locomotive bells are now rung by air, and are in many instances constantly in use over the division, the wear to bell yoke pins and frame bearings is excessive. When renewals are required the bell frame in the majority of shops must be removed from the boiler to a drill press or lathe to line up the pin holes. It was found on the Chicago and North Western that this procedure was expensive and not always satisfactory, so one of its ingenious mechanics has designed the hand tools herewith illustrated which permit the work to be done on the engine in a few minutes.

The arbor is made of tool steel and is turned down on one end to receive the shell reamers which vary in size by thirty-seconds of an inch. The other end of the mandrel is squared to fit the crank or wrench to turn the shell reamer. The tapered cone is shown in position on the arbor, and held there by a coil spring. This arrangement ensures that this end of the arbor will be central and in line while the shell reamer is at work on the opposite hole. Conditions are simply reversed for either side of the yoke. This device is thought of very highly in the Clinton shop as a great labor saver, and one which insures round holes in perfect line with one another.

UNIVERSITY OF ILLINOIS STUDENTS

Registration at the University of Illinois began on September 18, and the work of the new year formally started on the 21st. The total enrollment of students on October 1 in the various departments at Champaign-Urbana was 3,620. Of this number, the College of Engineering is credited with 1,206, distributed as follows:

Architecture and Architectural Engineering	306
Civil Engineering	251
Electrical Engineering	290
Mechanical Engineering	275
Mining Engineering	21
Municipal and Sanitary Engineering	27
Railway Engineering	36
Total	1,206

LOCOMOTIVE FUEL OIL STATISTICS

No serious attempts were made in the United States toward using petroleum as a locomotive fuel until the Spindle Top field came in, when the Texas roads immediately took up the work of adapting locomotives to burn crude oil; the development of the California fields bringing the railroads of the Pacific Coast states into line as oil burners. The consumption of fuel oil by the railroads of the United States with the mileage figures as follows:

	Length of Mileage under Fuel Oil.	Total Mileage made by Oil Burning Loco.	Total Barrels Used.
1906	......	....	15,577,677
1907	13,578	74,079,726	18,855,002
1908	15,474	64,279,509	16,889,070
1909	17,676	72,918,118	19,939,394
1910	......	....	*23,000,000

*Estimated.

The mileage figures for 1906 are not obtainable, and those for 1910 are not yet completed, the consumption for 1910 being estimated and largely predicted on the increased consumption by the railroads of California oil which, for 1910 was 12,775,000 barrels, or 3,000,000 barrels more than was used in 1909. Out of 77,697,568 barrels of petroleum produced in California in 1910, a total of 50,720,000 barrels were used for fuel purposes, oil practically displacing coal as a railroad, steamship and manufacturing fuel on the Pacific Coast.

HARD STEEL IS NOW CUT WITH PLAIN DISCS of mild steel that are revolved at high speed. The discs are of boiler plate quality steel and about ¼ in. thick. They are revolved at about a speed of 20,000 ft. a minute. It is said that one of the discs will cut through a heavy channel section of hard steel, 12 in. by 6¾ in., in 15 seconds. The disc remains cool while cutting because of its large surface area and small point of contact. The metal cut also remains cool for a similar reason, although at the point of contact with the disc the temperature is very high. The explanation of this apparently wonderful feat of cutting steel with a smooth disc is that all the frictional energy of the disc is concentrated on an extremely small area of contact, and the cutting is accomplished apparently by local fusion.

STEEL CONTAINING OVER 20 PER CENT. of manganese is non-magnetic. A non-magnetic alloy is also produced by alloying 17 per cent. of aluminum with iron.

600 Ton Reinforced Concrete Coaling Station*

BALTIMORE AND OHIO RAILROAD.

A new reinforced concrete coaling station having a storage capacity of 600 tons and a hoisting capacity of not less than 125 tons per hour, has been designed and built by the Roberts and Schaefer Company, Chicago, for the Baltimore and Ohio R. R. Co., at Sir Johns Run, W. Va. There are two 2½ ton Holmen balanced hoisting buckets working in unison and traveling vertically from the bottom of bucket pit to the top of the hoisting tower and discharging automatically onto the chutes over the pocket. The pocket is arranged to deliver coal to locomotives on four tracks—two under and one on each side of pocket. The general layout of the station is illustrated on accompanying illustrations.

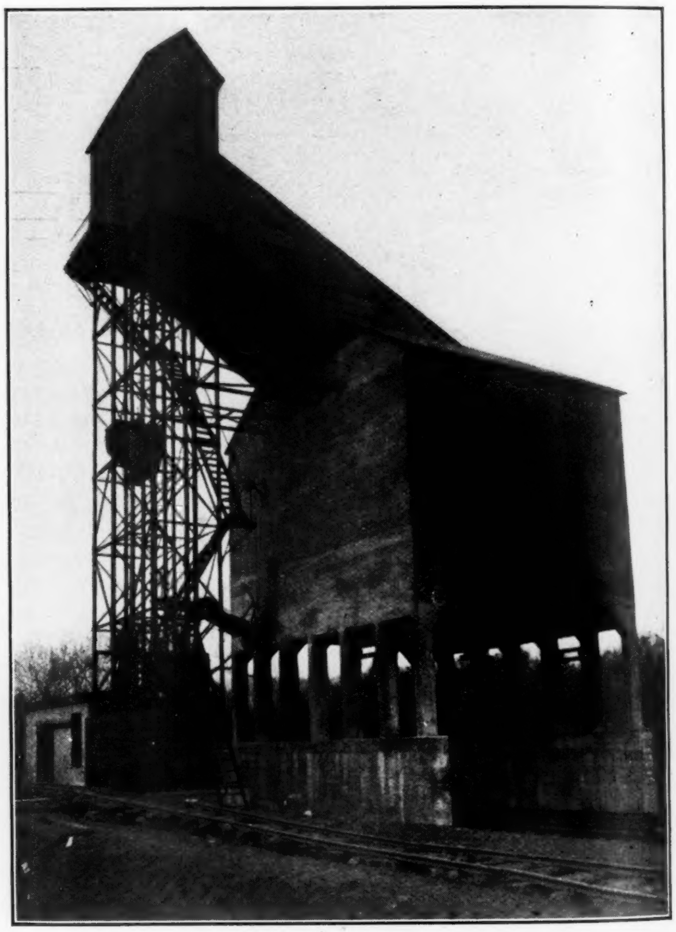
The receiving hopper is 20 ft. long and 15 ft. wide and built of plain concrete with well rounded valleys and corners, the surface being finished with 2 in. cement. The track stringers are 24 in. Bethlehem section connected with 15 in. channel separators and the rails are secured to the girders with special clips. In front of the receiving hopper are openings arranged with 2 Barrett self-operating revolving feeders to control the flow of coal and measure the quantity delivered to the Holmen buckets, thereby preventing waste of coal in the bucket pit. The base of rails of receiving track is 3 ft. 6 in. above that of coaling tracks.

Plain concrete mixed in proportion of 1 : 3 : 5 is also used for the bucket pit, which is 6 ft. wide and as long as the receiving hopper. The pit and the hopper are waterproofed on all sides up to 12 in. from the receiving track.

Under the pocket the main coaling tracks are 13 ft. apart while the outer tracks are 17 ft. from them on each side, in the center of which space rise the 2½ ft. concrete collision walls. The latter are 8 ft. high above the coaling tracks and go down into the ground 3 ft. Aside from the top and bottom there is no other reinforcement in the walls.

On the collision walls are erected the overhead coal pocket of 600 tons capacity. The pocket is 32 ft. wide across the tracks and 42 ft. in the other direction and reaches a height of 47 ft. above the base of rails. The head room under it is 21 ft. 6 in. while the clearance on each side of tracks is 7 ft. 3 in. There are four sets of undercut gates with heavy steel counterbalanced hooded aprons, one for each track, so arranged by counter hoppering that all coal in the pocket will be available with a minimum loss of space. The pocket is supported by seven columns on each collision wall, the five inside ones being 16 in. x 24 in. and two outside ones 12 in. x 24 in. The columns are reinforced with 1¼ in. rods, stiffened with occasional use of hoops made of ⅜ in. rods and designed to withstand not only the weight of coal and concrete, but to resist 40 lbs. wind pressure on the upper structure. The floor or bottom of pocket slopes on an angle of 40 degrees from the center to the walls over the columns and is built in one continuous slab from end to end, which is then counter-hoppered toward the openings. The slabs are 9 in. thick, including 1 in. sidewalk finish, reinforced with ⅝ in. rods, the end of which are bent up to resist negative moment at the supports. Additional rods are also provided to take care of shrinkage and temperature strain. Under the concrete slabs and between each two opposite columns is spanned a simple triangular truss with a hanger in the center and apex at the intersection of the sloping floors. On account of the enormous tensile stress coming onto the bottom chord of the truss, the method of securing the ends of the rods to the columns becomes an important factor. Also the fact that the intersection of the neutral axis of the top chord with the center line of the bottom chord is about 2 ft. away from the center of the column, multiplied the difficulties in reinforcing the ends of trusses. Great care was exercised in erecting the trusses to have the rods in the bottom chords tightly stretched before the concrete was placed in order to prevent cracks in the beams and possible deformation of trusses. The top chords are designed for both direct compression and flexure, the section being assumed as T-beams, as the floor slab undoubtedly comes into play to resist the combined stress above the neutral axis. The shear is taken up by bent up rods and closely spaced stirrups, as well as by the concrete itself.

The walls are divided into panels by means of pilasters, one over each column and at the center of walls across the tracks.



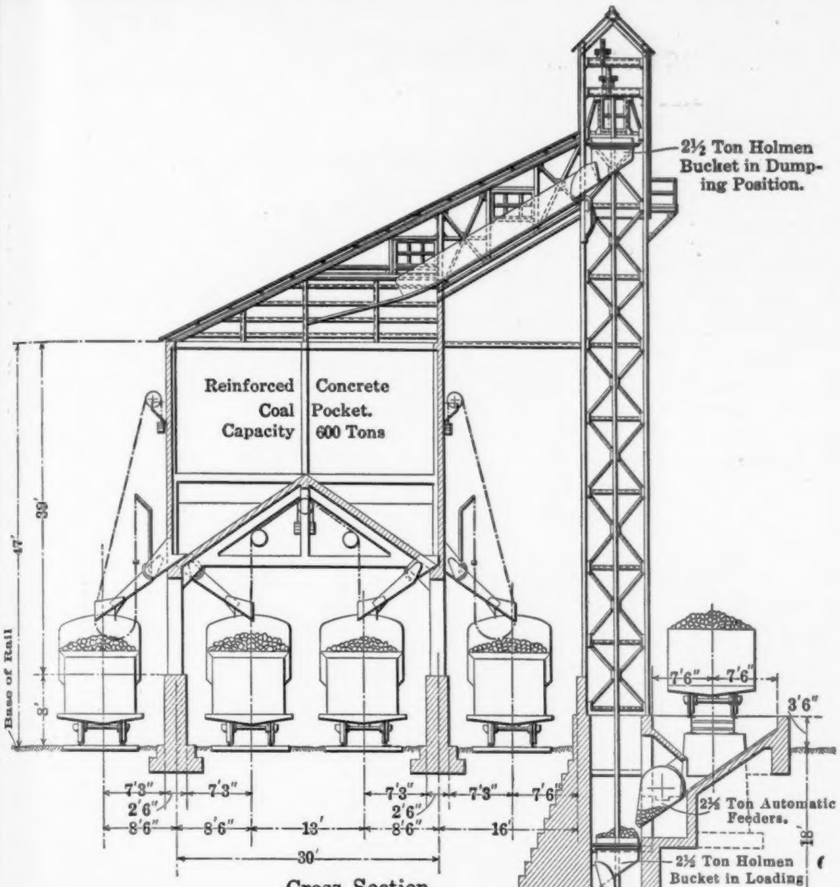
REINFORCED COALING STATION SERVING FOUR TRACKS.

The former walls are 6 in. thick and the latter 10 in., both straight for their entire height, but the amount of reinforcing varies with the depth of walls. The pilasters are in turn tied to those opposite with beams across the inside of the pocket. A provision is also made here to take care of the negative moment, temperature and shrinkage strain.

As the work on the pocket was to be done without interfering with the traffic on the main tracks, it necessitated construcing an overhead temporary structure to support the trusses, floors and a part of the walls and the forms. In order to accomplish this, 9 20-in. I-beams were swung across the tracks just below the bottom chords of trusses, leaving a clearance of 19 ft. above the rails.

Concrete mixed in proportion of 1 : 2 : 4, the stones small enough to pass a ¾ in. ring, was used in the construction of the

*Description prepared by H. S. Shimizu, designing engineer, Roberts & Schaefer Co.



Cross Section.

PRIZES FOR GOOD TRACK

Fifty-four hundred dollars as prizes for maintaining sections of track in the best condition during the past year have been awarded by the Pennsylvania Railroad to supervisors and assistant supervisors. General Manager Long, with a party of about 200 operating officers of the Pennsylvania Railroad, made the annual inspection, and the prizes were awarded upon the return of the inspection party on October 4. The first prize, amounting to $800 for the supervisor and $400 for the assistant, awarded for maintaining the best section of track throughout the past year, was presented to C. M. Wisman, supervisor, and William F. Miller, assistant supervisor, who have charge of the track between Tullytown, Pa., and Deans, N. J.

Among the methods used to learn the exact condition of the "line and surface" of the main lines was to place glasses of water on the sills of windows on each side of the Special Inspection car at the end of a running train. Every "spill" of water occurring on each supervisor's section was carefully recorded as a demerit. There was also a machine on the floor of the car which recorded the jolts of the train from side to side and up and down. These records formed the basis on which the committee decided the prize awards.

pocket, while the concrete for the collision walls is 1 : 3 : 5 mixture same as the other part of the foundation.

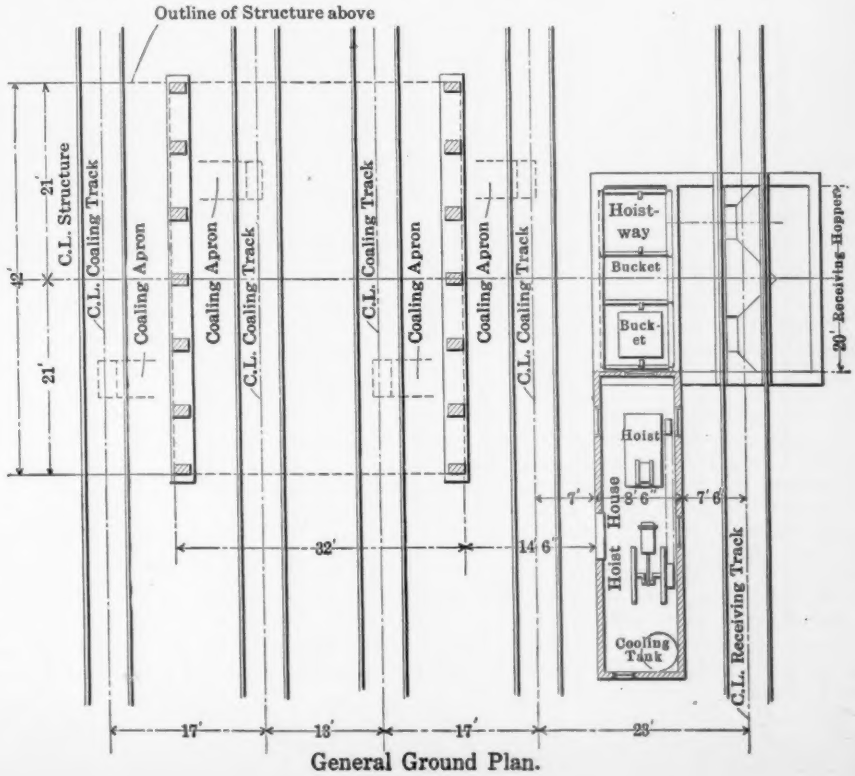
As is shown in the illustration, the hoisting tower is 7 ft. 6 in. by 18 ft. 8 in. in plan and 80 ft. high above the receiving track. It is built with substantial structural sections, cross-braced on four sides as well as on the inside bents and rigid enough to withstand the strain from live load due to the traveling buckets and 40 lbs. wind pressure on the exposed surfaces. The canopy over the pocket and the bridge from the tower are also steel framed and covered like the upper portion of tower, with American Ingot Iron on the walls and Carey's Magnesia Composite on the roofs laid on 1 in. roof boards.

The hoist house is located next to the bucket tower even and level with the top of receiving hopper. It is built with reinforced concrete throughout and equipped with 20 h.p. Ohio gasoline engine with Roberts and Schaefer Co.'s standard reversible hoist, a cooling water tank and service stop to prevent overwinding of buckets.

After a short experience with this coaling station, the B. & O. R. R. Co. awarded a contract to the Roberts and Schaefer Co. for three duplicates which are now under construction at La Paz Junction, Ind., Warwick Ohio, and Rowlesburg, W. Va.

THE LARGEST CANTILEVER CRANE in the world, recently made by a British firm for a Japanese dockyard, is capable of dealing with a load of 200 tons at a radius of 95 ft. A still larger one is now being built for the Japanese navy, to have a load capacity of 200 tons at 105 ft. radius.

ABANDONED RAILROADS.—Records for 1910 show that in the United States there are 81 abandoned railroads. From 18 the rails have been removed, and 34 are described as "not in operation" or "operation suspended." In regard to the first class, the franchises seem to have expired by disuse, but the tracks are still in evidence. In the second class, the companies have pulled up stakes and quit. In the third, a variety of causes may have contributed to the stopping of wheels.



General Ground Plan.

A Railway Experimental Station

Has the locomotive testing plant at Purdue University produced any results of value to the railroads at large since its installation? Have such results from the Pennsylvania Railroad locomotive testing plant, as have been published, been of any value? Are the results from the brake shoe testing machine, the University of Illinois dynamometer car, the triple valve testing rack, and of many other special tests, returns of which have been given freely to all who have need of them, worth while? If so, why is it not possible to carry the same idea further and obtain equally valuable returns along other lines? Some of the universities, of course, are doing this in a small way, but their facilities will never permit them to operate on the scale that should be attained. The best results can probably only be presented by an experimental station wherein all railroad problems, so far as they can be handled in a properly equipped laboratory or testing station, established and operated under the direction of all the railroad companies through the American Railway Association or by the government through the Interstate Commerce Commission.

In the October issue of the *Engineering Magazine*, Benj. A. Franklin discusses at some length what he calls "An efficiency experimental station for the railroads." While Mr. Franklin's idea is the establishment of such a station principally for testing out scientific management in the railroad field, it seems possible to so plan a station along the lines suggested which would be of equal or more value in investigating problems that are not usually associated in the minds of most people with scientific management, although probably the author in using this term includes in it everything which tends for greater efficiency, be it either design, material or operation.

There probably is no one field of activity in the country which is constantly engaged in experiments equal to the railroads. There is no activity which is so quick to accept new suggestions and give them a fair trial. Beyond doubt there is no business which is so open to the introduction of better methods that show the slightest indication of becoming eventually profitable. Experiments, however, are always costly and in the way necessity compels them to be carried out on most roads, they are considerably more costly than would be the case under more favorable surroundings. In a great majority of cases, particularly in the smaller things, the present method is the only satisfactory one. But, on the other hand, in many of the larger features satisfactory conclusions are almost impossible because of the many uncontrollable affecting conditions, and it is these problems which, because of the probability of doubtful conclusions and the knowledge of the enormous expense involved, most of the railroad companies hesitate to undertake; that the co-operation scheme suggested seems best suited to solve. Scientific management in its narrow meaning is, of course, one of the most important of these and in its broad meaning includes many of them.

We give below abstracts from Mr. Franklin's article which make clear the nature of his suggestion, and also criticisms of the plan by several more prominent operating officials and others which were published with it:

Investigations and experiments cost money. Attainment costs much money. If every railroad is to make the investigation and experiment separately, starting with no data and no experience, the attainments will necessarily be varied. Some will record failures. Many will not start until others have finished. Many will give up the experiment in its progress. Some will attain success. But in the aggregate, under such conditions, there will be the maximum of trouble and expense. Not that it wouldn't be worth while, even then.

There are, however, certain conditions existing with our railroads, the consideration of which may point to a more economical solution of the problem.

The needs of all railroads in the matter of operation have a great similarity, so that a solution of a general problem for one road points the way to a solution for the others.

The railroads are not essentially competitive. There is under normal conditions no business reason why any advantage of method one gains should not be free to all.

If, therefore, there are problems of improvement in shop and operative management to be worked out (and no experienced man, in or out of railroads, will deny that there are), why should the railroads all work them out separately, with a consequent waste of time and money?

If they should not, then we find ourselves arrived at a remedy. They must work them out all together, and perforce at a central experiment station maintained by and for all.

There is nothing radical in such a proposition, of course. The Government departments, agricultural and others, have removed the radicalism. There is nothing contrary to the spirit of the times in it. The spirit of the times moves toward centralization, and the law does not forbid it when in the general interest. It is not, indeed, contrary to the practices of the railroads themselves, since in their traffic and other associations they have met the problem in this very way.

The vital question, it would seem then, is whether such a proposition would be in the interest of economy and advanced practice. It would certainly seem that this would be the case, and perhaps a brief imaginative construction of such a station would help to bring judgment to the matter.

The railroads might form, under separate incorporation, a central experiment station, each road, let us say, furnishing capital upon some unit basis agreed upon as equitable to all, such possibly as car-miles. The amount of capital for this purpose need not be large—say $5,000,000, to be expended only for equipment.

The operating expenses could be met, at first partly, and eventually entirely, by charges for services rendered to the railroads, or they could be divided pro-rata yearly between the railroads. It would seem that they need not be large—let us say, $1,000,000 a year.

One of the valuable departments of such a station would be the repair shops. A large shop, of the size of the average railroad shop, run entirely in the interest of experiment, could furnish from itself alone values to the railroads entirely compensating for the expenditure. The railroads could furnish it ample work in locomotives and cars to be repaired, to be charged for, of course—a first source of income.

It would seem necessary that the employees of such a shop should have no entangling alliances that would prevent their working strictly in the cause of the advancement. It does not seem that it would be a difficult proposition to man such a shop with independent and skilful men, and the opportunity for technical-school and college graduates here would be valuable both for themselves and the station.

Here, then, could scientilc management find its entry properly into the service of the railroad. Here could be developed that functional form of organization which in studying, in planning, in preparing the way for, and the equipment of, the army of workers, and in instructing them, could, without doubt, lead to the aid of the railroads an effective efficiency which they neither now possess nor indeed believe possible. The railroads must see to believe. Here could be developed the object lesson.

Here the organization and methods of scientific management could be developed in relation to this work, and the practice perfected. From this station could go forth experts who would develop it in the railroad shops. In this latter work, of course, the trade unions would have to be reckoned with; but there is very much in the methods of scientific management to which the unions can at present offer no objection, and education in these matters will eventually lead them to accept the features of reward for efficiency, which now find small favor with them.

From such a shop there should issue constantly valuable results of experiments covering the whole range of shop practice—the efficiency of tools, the best tools for given purposes. Indeed, would it not pay the tool manufacturers to supply their tools to this station free of charge? Records of operation costs on standard operations sent to the railroad shop would have a stimulating result. The best methods of repair, the most economical, efficient repair, and indeed innumerable economical results, must necessarily emanate from such a shop once it is organized under an efficient head.

But the repair shops would necessarily be only one department of this central experimental station.

There would haply exist an operating department of sufficient force and equipment to make vital experiments in economy of operation, coal values, roundhouse practices, periodical necessities of engine overhauling, equipment, preservation, etc. It goes without saying, of course, that in all departments of such a station experiments with new inventions to discover their real

values of service and economy to the railroads would find a decidedly legitimate place.

Similarly, there would be established departments of experiment along other lines of railroad activity. Some of the departments, such perhaps as that of statistics, would find in this central station only headquarters, while through experts to study, and later to install, it might evolve not merely vital and valuable statistics, but—what would be very much to the point in railroad work, where clerical labor is a large item of expense—it might develop a much greater simpliciy of records and a higher quanity standard of efficiency when the method was fixed upon.

Given, then, this central station equipped and organized with the necessary departments, it would be able to call to its aid from time to time experts from outside to suggest, to aid, and to formulate; and, of course, it is almost needless to say that the talent active on the railroads themselves would be essential in co-operation.

Once well started, such an experiment station would of course be held accountable to attain and formulate definitely practices for improvement of any and all railroad problems in a practical way, and to report them in an understandable manner to all the railroads. But more than this, it must also be prepared through its experimenters to install in a diplomatic and successful manner, upon request, any methods so reported. Indeed, a natural consequence of such a station would be that the experimenters would necessarily spend much time within the railroads outside of the station, and both an advantage to the railroad and a danger to the station would be the abstraction of these experimenters by the railroads for practical service.

Such, in the rough, is a plan whereby the railroads with similar problems and needs, and the strong necessity for economy and organization of the highest order, and subject to rapid developments, might well operate to bring about these elements of improvement with the minimum of expense and the maximum of efficiency and rapidity.

To recapitulate:

The railroads have need of economy beyond the ordinary industry, because of their direct public service and the Government control of rates.

Their widely spread area of operation and multifarious activities make them the sure prey of waste of labor and material, except under the most scientific development of organization and management.

Their problems of operation bear such a similarity to each other on all roads as will permit of single solutions for all alike.

They are not essentially competitors, and consequently there exists no business reason why the advantage of successful experiment should not be free to all.

The spirit of the times and the law of economy call for centralization of experiment for better methods.

A central experiment station could work out, in a comparatively short time, a successful solution of very many railroad problems.

Such a plan would bring about the use on all railroads of many practical and highly economical methods, much in advance (in point of time and perfection) of their present likelihood of adoption. Such a plan would save much duplication of experiments involving useless expenditures and variations of results.

It is not improbable, indeed, that some such plan has rested in the minds of many who have a genuine interest in the matter. Such a plan operated by the railroads and in their interest solely, with money furnished by them, would eventually meet from the railroad a practical and rapid co-operation, such as it is not in the nature of things would be forthcoming to any like ideas offered from outside sources.

Provided all other obstacles and objections are met, can the railroads who have proven their ability to co-operate with each other in lobbies, in rate fixing, and in matters that deal with external affairs, get together on such a plan as this, which would deal very intimately with internal affairs?

COMMENT ON THE SUGGESTION.

E. P. Ripley, Pres. Atchison, Topeka & Santa Fe Railway, doubts the efficiency and value of such an experimental station, stating that we already have thousands of students in mechanical matters in our schools and universities, and each road has scores of the graduates of these institutes, each one animated by a personal ambition to discover something better and cheaper than the ways now used. He states that he believes that there is now ample opportunity for the development of any new idea that promises well. That there are great wastes in the business is admitted, but it is charged that these are economic wastes largely due to the attitude of the government which compels their continuance. Mr. Ripley concludes his statement by stating that while very much could be accomplished by co-operation among the railways in many ways, he is convinced of the general futility of the plan proposed.

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Julius Kruttschnitt, Director of Maintenance an Operation of the Harriman Lines, discusses the subject at some length to indicate the weakness of the suggestion. His comment is in part given below:

A mere enumeration of the principal elements of efficient railroad operation will show the impracticability of reproducing actual operating conditions in an experimental station.

The first and foremost efficiency factor is *car and train loading;* given this, we have as a close second *train movement* that wastes neither power, by light movement of cars and locomotives, nor labor, by delays and consequent overtime payments.

Following these are:

Efficient consumption of fuel in the locomotive—a very different matter from its consumption in a laboratory or stationary boiler.

Handling foreign freight cars to avoid rental payments when idle.

Water purification.

Use of lubricants.

Shop practices.

Preservation of timber from decay, and from crushing under rails.

Rail and rail-joint design, and chemical composition.

Receiving and delivering freight.

Track and bridge maintenance practice.

Design of locomotives and cars to fit service conditions.

Although Mr. Franklin's suggestion is broad enough to embrace all railroad operations, it seems directed principally to possible economies in the *shop* practices of railroads, an important and expensive branch of the service, but by no means controlling in efficient operation. Maintenance of the equipment of the roads of the United States at the present time costs three hundred and sixty-four million dollars annually, or 22.75 per cent. of the operating expenses. Of this amount approximately 50 per cent. was paid for material and charges which cannot be altogether controlled by the railroads, so that the amount on which economies are mainly to be effected is one hundred and eighty-two million dollars, or 11.4 per cent. of the operating expenses. A loose estimate, made before the Interstate Commerce Commission,, of possible economies in shop practice, of a million dollars a day, or three hundred and sixty-five million dollars per annum, was immediately accepted as proven, and has since passed current at its face value. Whilst not altogether true, or fair to the railroads, it has unquestionably prompted study on the part of railway managers, and Mr. Franklin and the public can hardly be blamed for misunderstanding the situation.

Whilst the efficiency with which a railway is managed must be gauged by the results produced by the plant as a whole, no one will deny that some parts of it are not worked to maximum efficiency. It can be shown that the average number of passengers per train is much less than the average train can accommodate; that the amount of mail handled per postal car is much less than the capacity of the car, and that the average freight train hauled by locomotives is much less than their potential hauling power. Whilst it thus may be easily demonstrated that the maximum *possible* efficiency with which direrent parts of the railway plant might be operated under *ideal* conditions is not attained, it is much harder to show that the maximum *practicable* efficiency under the conditions which exist and with which railway managers have to deal, is not approached. The railway manager has not, never had, and never can have, the same degree of control over the operation of his plant, and of each part of it, that the manager of a mercantile or manufacturing concern may exercise. Shippers demand, and properly, that freight shall be transported with regularity and expedition, and speedy and regular transportation is an important element in efficiency of operation. But it is often not practicable to move freight with the maximum speed and regularity obtainable and at the same time hold cars and engines at terminals until the maximum car and train loads can be procured. The railways might easily haul a much larger average carload of mail, but under postal regulations mail carloads are limited to about three tons, whereas express cars are loaded to the roof with twenty to thirty tons of express. Again, in passenger service, the reason why the railways average only fifty-four passengers per train when the average train has a capacity of at least one hundred and fifty passengers, is that the public demands, and properly, that it be given frequent and regular service, and frequent and regular service is incompatible with the maximum loading of trains.

The facts cited illustrate a point generally overlooked in discussions of railway efficiency; that is, that efficiency from the standpoint of the railway is often not the same thing as efficiency from the standpoint of the public. Efficiency from the railway standpoint may consist in loading cars and trains to their ca-

pacity and moving the minimum number of cars and trains to handle the business; it may involve a relatively slow speed, because the faster engines are driven, the greater amount of fuel they consume and the smaller the load they can pull, the result being that the cost of running the train is increased while the revenue derived from running it is reduced.

Now, when the public insists on a kind of transportation which is incompatible with the most economical operation, no one can justly criticise the railway managers for complying with the public's demands, and thereby failing to operate the properties with the maximum possible economy. If railway managers operate the properties, not with the maximum economy possible under certain *conceivable* conditions, but with the maximum economy practicable under *actual* conditions, they do all that can be reasonably asked of them. I think that the railways of the United States are operated much closer to the maximum *practicable* efficiency and economy than most people believe.

Far be it from me to depreciate efficient management in any department; but what I do wish to emphasize is, that much work is performed in an apparently wasteful manner on railroads because it is impossible to do otherwise and still give desired service. Equipment repairs cannot be concentrated in specially designed central shops; much of it has to be repaired in yards, and on sidings at outlying points, where special facilities cannot be provided. On one large system the general shop payroll is only one-fourth of the total shop payroll. If this proportion holds on all the railroads of the United States, that part of the $182,000,000 paid for labor that could be brought under scientific management is reduced to a very small part of the whole. The zeal with which the people enforce their will in regulating railroad operation, requiring damaged locomotives and cars to be cut out of trains on the spot—shop or no shop—with men and material for repairs to be provided regardless of distance, has aggravated the dispersion of repair forces, and has weakened supervision. In other railroad departments the public prescribes the hours of employment, and in many States, besides holding railroads strictly accountable for damages resulting from accident, the number of employees on trains is fixed regardless of economy or efficiency.

Efficient tools, shop appliances, and methods are not unknown to railway managers, many of whom are using the best of their kind; but here, as elsewhere, they can never afford to forget the paramount nature of their duty to the public.

The opposition of organized labor to more efficient methods is so well known that I need not emphasize it, but I may be permitted to explain the exceptional nature of this handicap, to the railroads. The manufacturer, with no obligations higher than those to his stockholders, can demand the most efficient service of his employees, enforcing his demands by dismissal or even by stopping operations and closing his factory. The pubic, however, demands that the railroads perform their duties, regardless of handicaps, and forbids them, under severe penalty, to lighten their burdens by combination or agreement; but with singular injustice and inconsistency permits, and even encourages, part of the public, through organization and combination, to embarrass, coerce, and, to a large extent, control railroad operations to suit themselves. In the event of a strike the public is almost invariably found on the side opposing its own servants.

Most large railroad systems have bureaus for inspecting, and plants for testing materials, and are at all times making experiments to promote economy and efficiency. The results are freely exchanged, so that I do not see what benefits, that are not now enjoyed, would be obtained from a central experiment station.

To recapitulate:

1. The railroads owe their first duty to the public and, if necessary, economy and efficiency in some departments must be sacrificed to attain efficiency of the railroad as a whole.

2. Their widely spread areas of operation make railroads unusually subject to waste. Therefore, most careful supervision is necessary.

3. Realizing the nature of their duties to the public, the railroads, in yielding to the demands of organized labor, frequently sacrifice both economy and efficiency for the sake of industrial peace.

4. If a private corporation becomes involved in industrial war, the victims are its stockholders only; if a railroad becomes involved in industrial war, the victim is the public.

5. The problems of operation are *not* similar on all railroads, and general solutions are not possible. Differences in fuels, water, climatic and topographical conditions vary the problems of locomotive and car design, as well as shop practice.

6. The railroads are not competitors in methods, and no reason exists why the fruits of successful experiment of one road should not be shared by all.

* * * * *

Harrington Emerson, in speaking on the subject, discusses at some length the principles of scientific management, particularly as applied to railroads. In speaking directly concerning the experiment station, he states "that five of the features mentioned by Mr. Franklin are axioms and that the sixth (a centralized experimental station could work out solutions), is also axiomatic but not exclusive, since there are other solutions than those of a central station. Admitting that a central station *could* work out a solution, *would it?*

In spite of their control by very able and exceptional men, enormous wastes occur in railroading. This must be due either to the men or the type of organization they work under. A foot walker, without bicycle, automobile or aeroplane, cannot make high speed, however athletic he is.

The minor ideals of railroading—economy and harmony—have been submerged by the greater ideals. The great railroad executives were generals, and great generals have always been wasteful and arbitrary. The men who could span the continent with rails and create an enormous traffic where none had been, who could regulate eighteen-hour trains between cities nearly a thousand miles apart, these men have not understood the principles underlying organization any more than they understood the principles underlying efficiency. As a consequence, as they themselves confess, their roads are dominated by labor combinations, and they accept wastes as inevitable.

If a railroad company cannot run a single one of its own shops economically, if each of a lot of railroads makes about all the mistakes possible in equipping and operating its shops, how can the executives of these roads organize jointly a model shop? They do not know how to do it individually, neither do they know how to select an independent executive who could.

There is a precedent for what ought to be done A generation ago, in the days of the Fisks and Drews, railroad accounting was unstandardized and vicious. At the whim of the executive (practices that lingered until railroad accounting was standardized by the Interstate Commerce Commission) operating expenses were capitalized, and *vice versa*, subsidiary accounts were skipped. Bondholders and shareholders lost all faith. A two-fold protection was ultimately evolved.

The issues of shares before they were valid had to be certified by an independent trust company, and the accounts had to be checked over and be verified by foreign chartered accountants, governed by principles and not amenable to local temptation or threats.

Accountants cannot, of course, check the efficiency of expenditures; they can only certify that certain rules governing expenditures and accounting have been observed.

Accountants certified to the Illinois freight-car-repair frauds. Bills for freight-car repairs were approved by the proper officials, they were charged to the proper account, and were therefore passed. Accounting professes to do no more. It cannot establish standards of expense, because this is as different an art from accounting as heaving the lead is different from calculating an eclipse. Even if standards are provided, accountants can only record, cannot enforce their attainment, because the enforcing of standards is as different an art from recording as dredging a channel is different from looking at the stars.

When I say that all the locomotives of a great railroad can be maintained for a cost of $0.05 a mile, it is not an answer to declare that no railroad succeeds in doing this, nor yet that any existing railroad mechanic finds himself unable to do it. The negative cannot be proved against me. The positive can be proved by me and by others who know. It is just as possible to set up a standard for each kind of operation, drilling, planing, turning, filing, fitting, shearing, punching, driving flues, as it is to set up standards of the shapes of the letters used in printing.

Every item of repair undertaken consists of a combination of the elementary operations, each with its standard time and cost determined and verified by experiment. All the separate items of repair at standard cost constitute the total standard cost for repair of a given locomotive; all the standard costs of all the repairs to all locomotives constitute the standard total repair cost for the year.

This would be laborious work. As to any road spending $5,000,000 a year in locomotive repairs, it might cost $100,000 a year for several years to establish, to attain, and to maintain standard costs, and save from one-third to one-half the repair bill. It is not at all necessary to take a year's time or $100,000. A qualified expert can go into any locomotive repair shop in the country, check up during a week fifty unselected operations, and show that the average time and cost of the lot ought to be reduced one-half. If given time to standardize both conditions and operations as to the items in question, the expert will reduce the time and cost one-half. This procedure has been gone through with over and over again in various locomotive building and repair shops, and over and over again the average efficiency has been shown to be as low as 50 per cent., and over and over again as to individual operations it has been brought up from 50 per cent. to 100 per cent.

Railroad wastes are like hygienic wastes. The latter are due to a great variety of causes—inheritance, unhygienic location, avocations, ignorance, indifference, the pressure of other and more powerful incentives. Norway has reduced its death rate

far below that of any civilized country, but first Norway realized the magnitude of the problem and put in a generation striving for its ideals.

Railroad wastes are like agricultural wastes.

Germany, in twenty-five years, has increased her output of staples per acre under cultivation between 30 and 40 per cent. Germany to-day averages per acre 100 per cent. more than is realized in the United States. The German agricultural society has been busy for twenty-five years.

When the whole country, governments, investors, executives, workers, patrons, communities, wake up to the fact that preventable railroad wastes aggregate more than two million dollars for every working day, that half this loss could be rather easily eliminated, certainly as easily as the increase of yield per acre and more easily than the lengthening of life in Norway; when it is realized that the cost of effecting loss elimination need not exceed five per cent. of the saving; when it is realized that the two-million-dollar-a-day gain will inevitably be distributed to those who do railroad work, to those who furnish railroad money and to those who supply railroad traffic—then, and not before, will the great problem be taken up seriously.

* * * * *

Louis D. Brandeis favors an experimental station of the kind suggested, but believes that it should be undertaken by the government, advancing his argument as follows:

In view of the obligations already assumed by the Government in the regulation of railroad rates and service, it should be prepared also to lend its aid to the railroads in advancing efficiency and in securing to them greater justice by permitting them to enjoy earnings on capital in proportion to the efficiency of their management. To this end a great forward step would be taken if the Government should establish a Bureau of Railroad Costs and an Experimenal Station in Railroad Economies.

The railroads are the greatest single industry in the United States next to agriculture. The interest of the general public to secure efficient and economical transportation is so great that the Government would be fully justified in incurring any reasonable expense to aid in increasing railroad efficiency. The expenditure would be similar to that now incurred by it in aid of more efficient agriculture.

The simple ultimate unit costs of each operation in every department of every railroad ought to be ascertained. They should be properly supervised, analyzed, classified and compared, so that each railroad should have the benefit of knowing the lowest unit cost of each operation attained by any American railroad, and how it was attained. This information should be disseminated as the Government now disseminates other useful information through the various bureaus of the Agricultural Department, the Department of Labor and Commerce, and the Department of the Interior. There should also be established an Experimental Station in Railroad Economies.

Such a station could be conducted similarly to the present experimental stations in the Department of Agriculture which are so potent in raising the standard of agriculture in the United States.

The Government now undertakes, through its Bureau or Office of Public Roads, under the Department of Agriculture, to advance with excellent results road building throughout the United States. The co-operation of the Government in furthering improvements in railroading would be infinitely more effective. It would undoubtedly develop valuable inventions and discoveries in its own laboratories, as the various experimental stations of the Agricultural Department have done. But it would be of even greater service in testing the inventions made and methods suggested by others and bringing to the attention of the railroads those of especial value. There are undoubtedly in existence today hundreds of inventions of greater or less significance—hundreds of new methods which, if adopted, would enhance the efficiency of railroad operation, and introduce economies of wide scope, but which are not known to the operating men because no adequate means exist for bringing them to their notice, which are unused because no single railroad is willing to give the time or incur the expense of testing their value; or because the inventor or discoverer is unable to secure a hearing or trial. There are undoubtedly also a large number of devices and methods in use in foreign countries of which our railway managers have either no knowledge or have but inadequate information. It is a proper function of our Government to make such investigations and to give to the railroads and to the public the full benefit thereof.

AN APPROXIMATE RULE for the length of belting is as follows: Add the diameter of the pulleys together, divide the sum by 2, multiply the quotient by 3¼ and add the product to twice the distance between the centers of the shafts. An even better rule than this is to cut out the figuring and use a tape line round the pulleys.

THE VALUE OF THE BRICK ARCH

What is probably one of the most valuable and accurate road tests of a locomotive ever made was conducted about a year ago on the Pennsylvania division of the New York Central & Hudson River R. R. under the charge of a committee which included representatives of the American Locomotive Co., Pennsylvania Railroad and New York Central. The tests were made on a 2-6-6-2 type Mallet locomotive and in addition to determining accurately the general features of this type of locomotive, the value of a high degree superheater, the brick arch and a locomotive stoker in this class of service were also investigated.

The Pennsylvania Railroad's dynamometer car was used and the greatest refinement and accuracy were present in connection with instruments used, methods followed and observers selected. Results of great value and interest were obtained, and in addition to these given below, it is expected that others will appear in these columns in future issues.

One of the most striking features developed during the tests was in connection with the fuel saving or capacity increasing value of the brick arch. The locomotive equipped with a superheater was operated on a number of runs without a brick arch and was then equipped with a "Security" arch and similar trips were again undertaken. The information thus obtained led the committee in its final report to the following conclusions:

"Data in reference to the performance with and without fire brick warrants the conclusion that the application of fire brick to this type of locomotive using this grade of fuel, may be expected to result in a saving of about 11 per cent."

An analysis of the coal used, of which there were two different grades, show approximately the following:

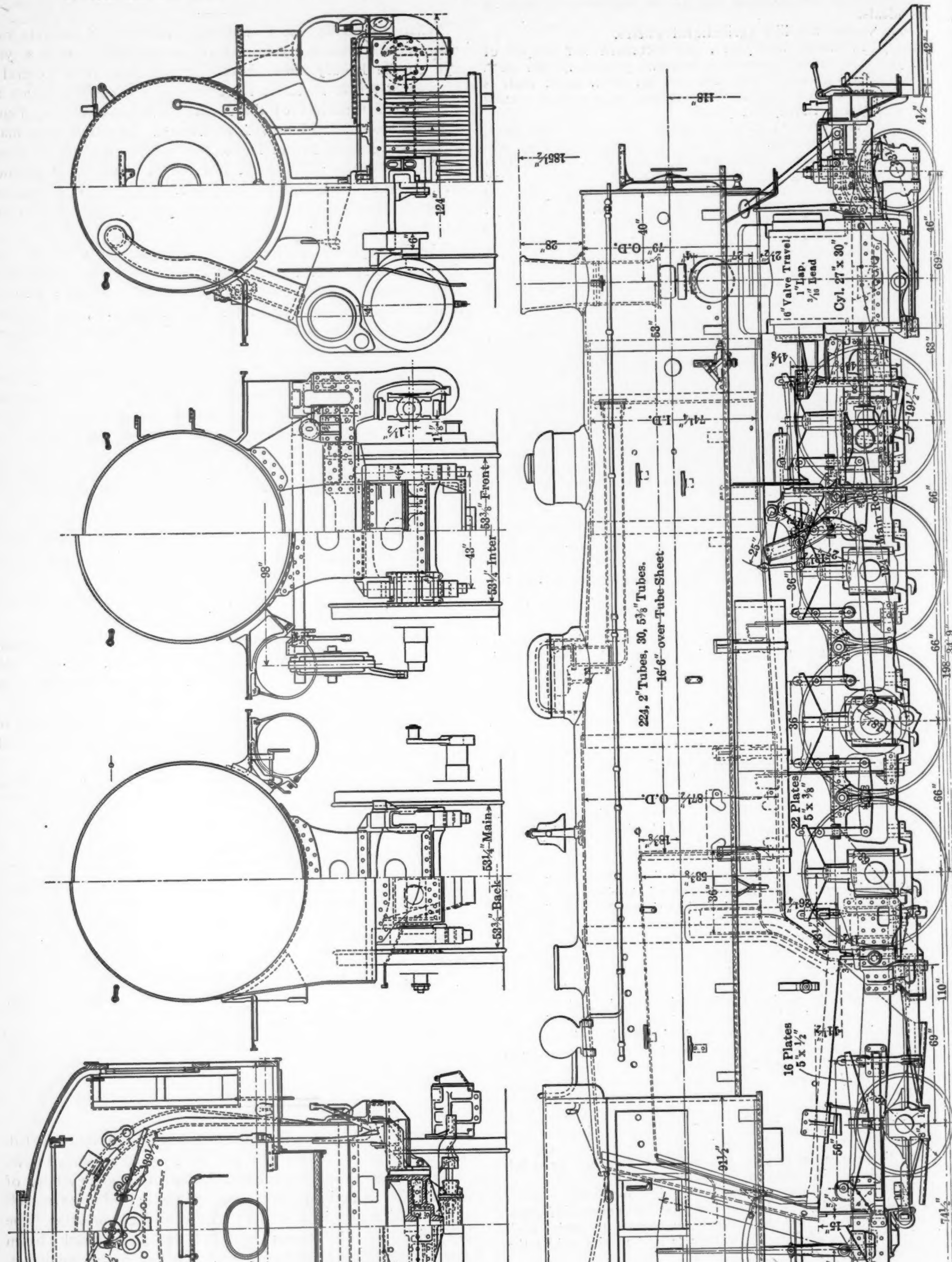
Volatile matter from about 25 to 27 per cent. Fixed carbon, 65½ and 64 per cent. Ash, 9½ and 9 per cent. Moisture determined separately ran over 2½ per cent., and sulphur, 1 to 1.5 per cent. B.T.U's averaged about 13,800.

In the following table are given the average of six trips of the locomotive equipped with superheater, hand fired, both with and without a brick arch:

	With Arch.	Without Arch.	Per Cent. Increase
Average tons back of tender	3,612	3,365	
Average running time, hours	4.32	4.07	
Average speed running m,p,h	13.6	14.4	
Coal consumed per hour with throttle open, lbs	4,021.5	4,633.	
Dry coal fired per hour, lbs	3,924	4,514	15*
Equivalent evaporation per lb. of dry coal	9.65	8.47	14
Equivalent evaporation per hr. per sq, ft. H. S	9.57	9.66	
Boiler horsepower	1,097.1	1,106.8	
Draft in smoke box, front of diaphram	5.4	5.79	
Temperature in smoke box	515.2	517.6	
Temperature of fire box	1,797.	1,711.	
Thermal efficiency of boiler, per cent.	67.66	58.56	15.5
Ton-miles per ton of coal	25,595	21,899	16.8
Dry coal per dynamometer h.p. per hr.	3.07	3.42	10.2*
Thermal efficiency of locomotive	6.02	5.32	13.1

* Decrease.

"TESTS OF NICKEL-STEEL RIVETED JOINTS," by Arthur N. Talbot and Herbert F. Moore, has just been issued as Bulletin No. 49 of the Engineering Experiment Station of the University of Illinois. This bulletin describes tests of riveted joints of nickel-steel in tension and in alternated tension and compression. The slip of rivets and the strength of joints were determined. From the tests, the general conclusion is drawn that in riveted joints, designed on the basis of ultimate strength, the use of nickel-steel may be of advantage; but that in riveted joints designed on the basis of frictional hold of rivets, while it may be advantageous to use nickel-steel for the plates, rivets of ordinary steel seem to resist slip as well as rivets of nickel-steel. Copies of Bulletin No. 49 may be obtained gratis upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.



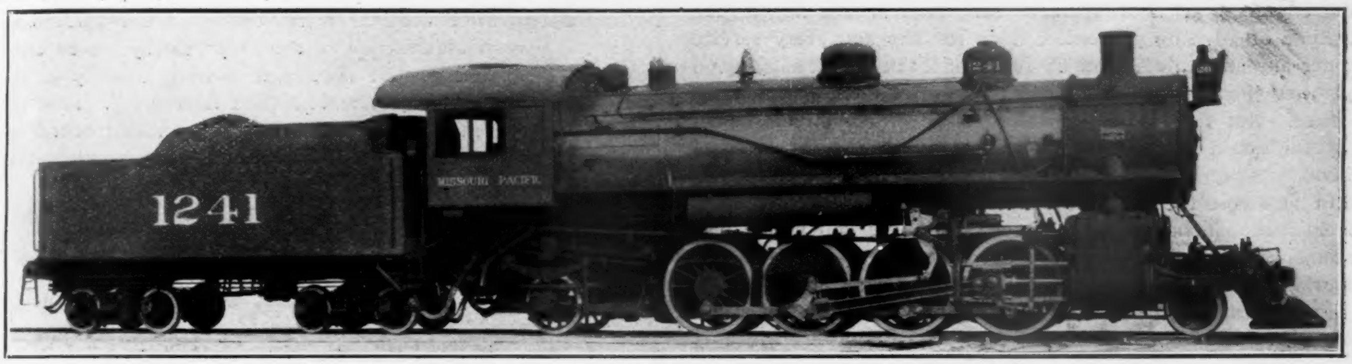
AN EXAMPLE OF THE LATEST IDEAS IN FREIGHT LOCOMOTIVE FOR HIGH SPEED AND AMPLE BOILER POWER.

POWERFUL FREIGHT LOCOMOTIVE WITH SUPERHEATER

MISSOURI PACIFIC RAILWAY.

Among the locomotives recently turned out of the Schenectady works of the American Locomotive Company were 50 of the 2-8-2, or Mikado, type for the Missouri Pacific Railway, which are interesting as indicating the present general tendency in freight locomotive design.

These locomotives use superheated steam at 170 lbs. pressure and have cylinders 27 x 30 inches, giving a tractive effort with 63-inch wheels, of 50,000 lbs. The weight on drivers of 209,500 lbs. is about 76 per cent. of the total weight and gives a factor of adhesion of 4.19, which is not far from the average ratio for this class of power.



FIFTY OF THIS TYPE HAVE BEEN DELIVERED TO THE MISSOURI PACIFIC RAILWAY.

While there is nothing particularly unusual in this design, it will be noticed that the boiler, while comparatively small, indicating a limit on the total weight allowed, is particularly well designed to take full advantage of the type of locomotive. This feature is noticeable in the depth of the throat sheet, which is 26¼ inches below the barrel and is carried up at an easy angle, tending to assist free circulation into it from around the bottom of the combustion chamber and barrel of the boiler. This gives liberal space above the grates and by the insertion of a 36-inch combustion chamber gives an opportunity for more complete combustion before the gases enter the tubes.

The firebox is made 66 inches in width inside the sheets, giving a side sheet which flares outward somewhat at the front end. The back head, however, is made smaller and the sheets are gradually brought in at the top, the inner firebox sheets narrowing about 9 inches on the center line of the boiler, and the wrapper sheet about the same.

The use of a combustion chamber in connection with the Schmidt high degree superheater reduces the tube heating surface to 2,614 sq. ft., which seems very small for a boiler and locomotive of this size. It has been found, however, that the combustion chamber is more valuable for evaporation than would be equivalent length of flues, and this taken in connection with the economy and capacity given by the superheater, which is at least 50 per cent. more valuable than equal space filled with flues, fully explains this condition, and there is little doubt but what this boiler will be equal to any reasonable demand.

It will be noticed that the customary practice of the builders for steam pipe design has been followed in this case, and also that an extended piston rod, the front end of which carried on enclosed guide, supported by the cylinder head and bumper beam, has been applied. The standard guide for the valvestem crosshead, which is adjustable for wear, has been used, and in all other particulars the locomotive follows the well-established designs of the builders.

The general dimensions, weights and ratios are given in the following table:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. coal
Tractive effort	50,000 lbs.
Weight in working order	275,000 lbs.
Weight on drivers	209,500 lbs.
Weight of engine and tender in working order	431,100 lbs.
Wheel base, driving	11 ft. 6 in.
Wheel base, total	34 ft. 9 in.
Wheel base, engine and tender	67 ft.
RATIOS.	
Weight on drivers ÷ tractive effort	4.19
Total weight ÷ tractive effort	5.50
Tractive effort × diam. drivers ÷ heating surface*	848.00
Total heating surface* ÷ grate area	75.00
Firebox heating surface ÷ total heating surface* %	6.85
Weight on drivers ÷ total heating surface*	56.50
Total weight ÷ total heating surface*	74.30
Volume both cylinders, cu. ft	19.86
Total heating surface* ÷ vol. cylinders	186.00
Grate area ÷ vol. cylinders	2.48
CYLINDERS.	
Kind	Simple
Diameter and stroke	27x30 in.
VALVES.	
Kind	Piston
Greatest travel	6 in.
Outside lap	1 in.
Inside clearance	0 in.
Lead	3/16 in.
WHEELS.	
Driving. diameter over tires	63 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	11x12 in.
Driving journals, others, diameter and length	10x12 in.
Engine truck wheels, diameter	33½ in.
Engine truck, journals	6½x12 in.
Trailing truck wheels, diameter	42 in.
Trailing truck, journals	8x14 in.
BOILER.	
Style	Conical
Working pressure	170 lbs.
Outside diameter of first ring	75¾ in.
Firebox, length and width	108⅛x66 in.
Firebox plates, thickness	⅜ & ⅝ in.
Firebox, water space	F. & S.—4½, B—4 in.
Tubes, number and outside diameter	224—2 in.
Tubes, superheater	30—5⅜ in.
Tubes, length	16 ft. 6 in.
Heating surface, tubes	2,614 sq. ft.
Heating surface, firebox	254 sq. ft.
Heating surface, total	2,868 sq. ft.
Superheater heating surface	558 sq. ft.
Grate area	49.5 sq. ft.
Smokestack, diameter	18 in.
Smokestack, height above rail	187⅝ in.
TENDER.	
Frame	Cast Steel
Wheels, diameter	33 in.
Journals, diameter and length	5½x10 in.
Water capacity	8,000 gals.
Coal capacity	14 tons

*Equivalent heating surface = 3,705 sq. ft.

PROCEEDINGS OF THE INTERNATIONAL RAILWAY FUEL ASSOCIATION.—We have been informed that the price of bound volumes of the proceedings for 1911 is thirty-five cents for the paper binding and seventy-five cents for the morocco binding, instead of $2.00 as stated in the review given in the September issue of this journal.

PLATES FOR LOCOMOTIVE FIREBOXES.—Although steel has been used experimentally, more or less, copper is the standard practice for Great Britain, the Colonies and Dependencies, the Eastern Hemisphere, and South America, whilst steel is the practice of the United States and Canada. The experience of the Eastern Hemisphere in regard to steel fireboxes is, that owing to serious corrosion on the water side and cracking of the plates after a very short service, this material has been abandoned.

SHOP FLOORS*

No floor surface is perfect from every point of view. The question of what floor to adopt for a shop is therefore always a choice between different combinations of good and less good qualities. While the factor of cost is apt to be considered the dominating one there are many situations in which cheapness is not the most important item in the choice of a floor; or to put the matter a little differently, it is sometimes economy to discard the floor that is cheapest in first cost for a different floor of higher cost which will justify this higher cost because of its better adaptation to the particular kind of service required of it. Therefore, although I have been asked to speak particularly about granolithic floor surfaces for shops, I am not in the attitude of advising granolithic floor for any and every service under any and all conditions. The granolithic surface has good qualities of great importance and I shall give these qualities due weight. But I shall also point out some of the circumstances under which it may be better in particular cases to put in wood floors.

In first cost the granolithic floor surface has the advantage over a wood floor, the cost of such a surface laid in the best manner being about equal to the cost of seven-eighths maple flooring delivered at the work. Besides this advantage in cost, the granolithic surface is fire-proof and waterproof, and will not decay or disintegrate under washing with water, which is one of the weak points of the wood floor.

There are other considerations involved in a decision between granolithic and wood floors concerning which it is unsafe to be very dogmatic without first defining very precisely the conditions of each particular case. Taking first such a matter as the wear of these two types of floor, it is easy to see that a wood floor is more easily repaired than a granolithic surface, and that repairs to a wood floor can bring the floor to its original maximum efficiency. A granolithic surface also can be repaired so that the new patches will be quite as good as the original surface, but the time and care required is much greater than with a wood floor. In repairing a granolithic surface it is necessary for best results to cut out the broken or defective portion down to the slab, leaving the cut with vertical edges. Next, the slab must be cut with a sand blast or acid until the aggregate stands out sufficiently to give a good bond for the new surface. Then the slab, and edges of the cut, having first been well wetted, must be grouted with neat cement mortar, on which the new finish is laid before the grout has set. Finally, the patch must be kept wet, and protected from use for at least a week. It is rarely possible to satisfy all these necessary conditions, and it is therefore true that under average practical conditions, the repaired portions of granolithic floors are inferior to the original surface in wearing quality.

In this contrast between wood and granolithic floors we have to deal with the question of workmanship. With a maple top floor the difference in wearing quality between a floor laid by a first-class carpenter and the floor laid by a merely average carpenter, is comparatively slight; but with the granolithic finish, ignorant or hasty work is disastrous almost from the outset. The granolithic finish, to give good service, must be laid according to the right theory, and every step in the workmanship must be first class. It is not at all difficult to get a first-class granolithic surface if one starts out with a determination to have it. Good work costs very little more than poor work. It must be admitted, however, that a great many granolithic floors have been unsatisfactory. Poor workmanship and wrongly chosen materials are the reasons.

Among objections which have been raised to the granolithic surface, one of the most prominent is the bad effect of the concrete floor upon the health and comfort of the operatives who stand upon it. There seems to be little doubt that long standing in one position on a concrete floor is not good for the operative. The reason for such ill-effects as occur is not the excessive hardness of the concrete floor, as is so generally supposed, but its great heat absorbing power. Wood is a poor conductor, a poor radiator, and therefore in general a pretty effective insulator. But when an operator stands for hours on a concrete floor the heat of his body is conducted from his boot soles into the concrete rather rapidly. In consequence of this drawing away of the body heat, feet and legs become more or less chilled, the circulation in the legs is slackened, and pressure on the skin of the feet, coupled with this sluggishness of circulation, due to the loss of heat, may easily give rise to sore feet and to various pains which are commonly classed under the head of "rheumatism."

That these bad effects do occur has conclusively appeared in investigation of the whole question made by the Aberthaw Construction Company about a year ago. For operators who are moving about while at their work, or who wear thick-soled boots, this excessive extraction of the body heat by the concrete floor is a negligible matter. For men working steadily at the machines in one position, some insulation is required. It is the practice in many machine shops to give the men foot boards or gratings of wood on which to stand. These do away altogether with any ill-effects from the concrete floor.

Granolithic floors have been attacked as not sufficiently durable under the rough usage of machine shops and foundries. Here again we have to take into consideration the all important items of materials, workmanship, and theory of construction. Nothing but the hardest natural stone in the way of a masonry floor can long withstand the wear of heavy trucking. The usual form of truck is provided with small diameter wheels having a flat tread and sharp edges, and such wheels with the tilting or slewing of trucks that is always in evidence in turning corners, will gouge and dig into any kind of floor. But the granolithic finish can be so made with such a high percentage of tough, elastic aggregate that the wear of trucking is borne almost exclusively by the aggregate itself. Nothing but steel and granite can outwear such a floor. It is the part of wisdom in laying granolithic floors over which there is a heavy truck traffic along certain lines, to provide steel plates or gratings properly set in the concrete to form lanes or tracks for the heavy trucks.

The nature of the tools, processes and products in a given shop bear on the decision between granolithic and wood floors. An edged tool dropped edge down on a granolithic floor would be damaged by the impact, while the same tool dropped edge down on a wood floor would dig into the wood and probably suffer no damage. Also, a manufactured products consisting of delicate metal pieces would be much more damaged by falling on a cement floor than on a wood floor. Still further, the dust produced by the wear of some granolithic surfaces has proved harmful to delicate machinery in some shops. The wood floor does not of itself produce a dust capable of any visible action as an abrasive. It is possible, however, by glueing battleship linoleum to a concrete floor to get many of the advantages of a wood surface. Tools and small manufactured articles are as little likely to break by falling on a linoleum surface as upon wood. The linoleum is without the innumerable cracks of the wood floor and therefore is much more easily kept perfectly free from dust. Linoleum is also an efficient insulation against loss of body heat to the concrete floor.

High resistance to wear of every sort and practically complete dustlessness, that is to say, freedom from the production of abrasive dust, can be secured in a granolithic surface properly made. It is always better that a granolithic finish should be laid on the floor slab while the latter is still green. A better bond between the finish and the slab can be obtained in this way than is possible after the slab has fully set. Unfortunately, the conditions governing the erection of concrete buildings usually put off the laying of the floor finish until all the rest of the building is practically completed, and this involves the need of using great care in cleaning and roughening the slab surface so that the granolithic finish laid upon it will get the best possible bond with the slab. Ordinarily the finish need not be more than three-quarters of an inch thick. Both for wearing capacity and for the avoidance of dust through abrasion of the concrete, the granolithic finish should contain the highest possible proportion of tough stone aggregate.

* Discussion by Leonard C. Wason on paper titled "Factory Construction and Arrangement," before Am. Soc. M. E.

For the most durable and most nearly dustless floor my rule is this: First, it is better to use no sand; sand grains are brittle, are early broken by the abrasion of feet, and cause dustiness. Use for an aggregate a stone suitable for macadam road, taking the sizes that pass through a half-inch round mesh screen, and nothing smaller than that passed by a 20 mesh screen. Mix the concrete dry of the consistency used in making blocks, so that considerable tamping will be required to bring to the surface enough water for trowelling. Finally, do the trowelling before the mortar sets. It is practicable in this way to get a surface that is 90 per cent. hard stone; the mortar, of course, wears more quickly, but its small area makes the results of this wear unobjectionable. Prolonged trowelling of a wet mixture brings to the top the "laitance" of the concrete, which is the part incapable of a true set. A top layer of laitance is therefore porous and wears down quickly. Even the fine particles of good cement should not be brought to the top, for they form a layer which is weakly bonded to the rest of the concrete, and which wears away quickly, appearing in the air as dust.

A PRACTICAL DEMONSTRATION IN FUEL ECONOMY

LEHIGH VALLEY RAILROAD

The impetus given the general question of fuel economy has without a doubt been one of the most prominent features of railroad operation during the past two years. Some of the savings effected have been remarkable in many ways and principally because they were secured through the co-operation of the engine crews and not through any particular improvement in existing conditions or in the quality of the fuel used.

The amount of money expended yearly for locomotive fuel is the largest single item of expense, excepting labor, that has to be met by railroads. Its magnitude is indicated by statistics furnished by the Lehigh Valley Railroad, which show that the fuel consumed by its locomotives for the year ending June 30, 1910, cost about $3,000,000. During this period there were in the service approximately one thousand firemen, which indicates that the cost of fuel handled by each fireman averaged $3,000.

The railroads generally realize that the fuel problem is largely in the hands of the engineers and firemen, and results have been chiefly achieved through direct appeal to the engine crews; intelligent direction of their efforts without arbitrary dictation, and the presentation of compelling and easily understood arguments to show just how potent the effect of a little extra care and watchfulness implies to the coal pile. For instance, the Lehigh Valley points out that if each engineer and fireman would reduce the cost of fuel one cent per locomotive mile, which would mean about two less shovelsful of coal per mile, it would amount to a reduction in cost of fuel of over $200,000 a year; or, in other words, a saving of $200,000 annually can be effected by engine crews making this apparently insignificant improvement. The saving cannot, of course, be made by one man alone, but it requires the united efforts of the one thousand firemen employed by the Lehigh Valley, and an equal number of engineers.

In order to emphasize what can be accomplished through this effort this road recently undertook the most remarkable practical demonstrations of which there is any record, and this was no less an achievement than that of running one engine through without charge on a heavy passenger train between Buffalo and Jersey City, a distance of 446.6 miles.

That the argument might be stronger and more appealing to the Lehigh Valley men, it was decided to use a locomotive which was a product of the road's own shop, and one of the class "F-6," No. 2475, was accordingly selected for the test. This is one of the 4-4-2 type which were designed in the office of the mechanical engineer, and remodeled in the Sayre shop, being placed in service in November, 1910. Although the railroad company calls these rebuilt engines, they are to all intents and purposes new, as only a few old castings were used in their reconstruction. These locomotives were not only well designed, but carefully constructed as well, which is evinced by the low maintenance cost since being placed in service. Their general appearance indicates that every man who worked on them felt the keen personal pride in his work which calls forth the best effort.

In view of this noteworthy run, which will no doubt remain as the record of individual locomotive performance for a long time, the principal dimensions of these class F-6 engines will be of interest:

Class	F-6.
Type	Atlantic.
Cylinders	21" x 26".
Diameter drivers (over tires)	77".
Boiler pressure	200 lbs.
Tractive effort	25,310 lbs.
Total weight of engine and tender	303,100 lbs.
Weight on drivers	99,700 lbs.
Fuel	Bituminous coal.
Firebox	Semi-wide.
Flues	374, 16' 2" long.
Grate area	51.2 sq. ft.
Heating surface, flues	3,164 sq. ft.
Heating surface, firebox	160 sq. ft.
Heating surface, total	3,324 sq. ft.

On June 21, 1911, locomotive No. 2475, with engineer John Corey, and fireman Frank Pettit in charge, left Buffalo on train No. 4, consisting of ten cars, and started on the run of 446.6 miles to Jersey City. This crew was in charge of the locomotive the entire distance without taking coal, or cleaning the fire. Between Wilkes-Barre and Fairview, a distance of 16.3 miles, with a grade of 95 feet to the mile, a helping engine assisted the train, which is the usual practice. The regular locomotive crews east of Sayre acted as pilots, engineer Corey and fireman Pettit not being familiar with that part of the road.

The following table gives the weight of the train and the distance each weight was hauled:

Stations.	Miles Run.	Cars Hauled.	Tons behind Tender.	Car Miles.	Ton Miles.
Buffalo to Bethlehem...	359	10	560	3,590	201,040
Bethlehem to Easton....	11.6	9	433	92.8	5,022.8
Easton to Jersey City...	76	7	372.8	532	28,332.8
Total	446.6			4,214.8	234,395.5

The summary of the run is given below:

Date	June 21, 1911.
Engine	2475.
Weather	Clear.
Temperature	80 degrees (average).
Rail	Good.
Wind	Light.
Coal	Bituminous.
Number of stops made	31.
Number of miles run	446.6
Number of cars hauled	10-8-7.
Total car miles	4,214.8.
Total ton miles	234,395.6.
Time leaving Buffalo	9. 58 A. M.
Time arriving Jersey City	10.01 P. M.
Time on road	12 hrs. 3 min.
Time scheduled	11 hrs. 57 min.
Time actual running	10 hrs. 40 min.
Number of times fire cleaned	None.
Times fire was raked	None.
Times grate shaken	6 (slightly).
Coal leaving Buffalo	34,050 lbs.
Coal arriving Jersey City	3.980 lbs.
Coal consumed	30,070 lbs.
Coal per train (or locomotive) mile	67.33 lbs.
Coal per car mile	7.134 lbs.
Coal per ton mile	0.128 lbs.
Coal per square foot grate area per hour	48.94 lbs.
Average steam pressure	195 lbs.
Minimum steam pressure	190 lbs.
Times water was taken	8.
Average speed, deducting stops	41.8 miles per hour.

The following table gives a comparison of some of the figures taken from this test run and corresponding figures for the year ending June 30, 1910:

	Coal per Pass. train mile.	Coal per Pass. car mile.	Shovels full per mile @ 14 lbs.
Train 4, June 21, 1911...	67.33 lbs.	7.134 lbs.	4.8
Average 1910............	132.2 lbs.	24.4 lbs.	9.4

From the above it can be appreciated what is possible by careful manipulation of a locomotive by its engineer and fireman. This performance in all probability is the most remarkable ever made in this country by an engine hauling a heavy train on schedule time. The total amount of coal used between Buffalo and Jersey City was 15 tons and 70 lbs., while the amount of coal consumed usually on this run is between 25 and 30 tons. When the distance run, train hauled, coal consumed, which was less than five shovelsful per mile, the time made up and the average steam pressure are considered, the performance reflects great credit on all who were instrumental in making it a success.